EDITORIAL

ATTENTION is directed to a typographical error on page 150 of the issue for October last. Item in Mr. R. W. White's article on B-Street Bridge, Hayward, giving the unit cost of cement paint at $0.25 per square foot should have read cement plaster at $0.02 per square foot. Correction should be made in order that the value of the reference may not be destroyed.

VISCOSITY is the fly in the amber that makes the transportation of crude petroleum in pipe-lines a knotty problem. Mr. E. I. Dyer, in a paper read before the San Francisco section of the American Society of Mechanical Engineers and reprinted in this issue, calls attention to the many complex phases of the question and also the attendant difficulties in the way of drawing definite conclusions. Since viscosity within certain limits is a function of the temperature, it would appear to follow that during the passage of a quantity of oil through a pipe-line the viscosity, and therefore the coefficient of friction, would increase as the oil cools until the point has been reached where further cooling ceases to have any effect upon the viscosity, and the curve from that point until the discharge of the oil would flatten out and become a straight line. To those who are addicted to calculus, this would appear to be an interesting problem, to determine just at what point a further reduction in temperature would cease to affect the viscosity of the oil, and also to ascertain what the rate of variation is between the high and low points. There would appear to be a need for some Carnegie who would be willing to construct an experimental line in the interest of science for the benefit of future builders and designers of pipe-lines who are now obliged to make everything big enough and strong enough to do the work under all circumstances, and follow empirical rules established by practice rather than an exact knowledge of the subject.

THE approach of a general state election in California, as well as many other states, draws attention to another of the many incongruities in the method of selecting some of our county officials. For example, take the office of county surveyor. Is there any reason why the voters should concern themselves as to whether a candidate is Republican, Democrat, or Progressive? What could be more absurd than a consideration of party affiliations in the selection of an engineer to fill an important and responsible post? After many years of agitation, the selection of the judiciary has been in a large measure removed from party politics. In carrying out this obviously necessary reform, the various bar associations have played a prominent part, and now endorsement of a candidate for judgeship by the bar association is generally equivalent to election, although it does not bar other candidates from entering the race. Why should not a similar work be undertaken by the local sections of the American Society of Civil Engineers with respect to passing upon the qualifications of candidates for county surveyor? As it now stands, it is hit or miss, whether the candidate elected is qualified for the position. It is not necessary to point out to the taxpayers the tremendous importance of this position. The present movement for better roads has taken such a strong hold upon the people that hardly a county in the Pacific Coast states has not undertaken to spend millions for this purpose. Should the selection of a man responsible for the judicious outlay of such great sums depend upon the whims of party politics? We think not. The engineering societies should take action looking toward the correction of this evil.

IT is difficult to believe that anyone, after reading what Mr. Latham has to say concerning the activities of the Kern County Oil Protective Association, can feel other than admiration for the broad constructive spirit that actuates the Kern County oil producers. If such an organization had been in existence ten years ago, the Kern River field would have been producing many times its present output. As it stands now, this field, while not entirely drowned, requires the most careful handling in order to continue production at anything like a profitable rate. Expensive devices are employed to dehydrate the emulsified oil and water from wells that might have been producing clear oil had protective measures been taken before it was too late. Shutting off water is, as Mr. Latham points out, a process that cannot be successfully undertaken in a haphazard manner by any roustabout that happens to be hanging around the lease. This work has been developed as a specialty by a few men who have attained such a high degree of skill that in many cases they guarantee successful shutting off or no pay. The sentiment of practically all of the operators, both large and small, is in favor of the aims and practices of the Association, and it is only by the existence of this recognition of the good work that is being done that the labors of those in charge can be made effective. Some months ago a plea was made for state aid and coöperation with the aims of the oil producers. A bill was prepared by Mr. Sutherland and passed both branches of the State Legislature, but was pocketed by the Governor. The principal difficulty in proceeding

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along the present lines is that the Association has no authority to enforce protective measures, and this is why state action was sought; to provide penalties for the man who destroyed his neighbor's oil well, just as similiar penalties are provided for destruction by one man of any other form of property owned by another. An industry that is adding perhaps $100,000,000 annually to the wealth of the state is worth conserving, and it would appear the part of wisdom not to wait until all the fields are in the present condition of the Kern River section. The Coalinga oil producers, some time ago, inaugurated a movement similar to that of the Kern County association, so the work is going on as well as it can until the scales fall from the eyes of the powers at Sacramento.

THE California State Mining Bureau, under the direction of Messrs. F. McN. Hamilton, State Mineralogist, and R. P. McLaughlin, in charge of petroleum investigations, has been doing excellent work in connection with the problems of water encroachments in the oilfields. Mr. McLaughlin has spent a great deal of time in the field on investigation work, and during the past month the State Mineralogist and members of his staff have conducted a series of meetings in the various oil-producing districts with the idea in view of obtaining an expression from the operators as to ways and means of securing state aid in dealing with the problem. It is believed that with the backing of the Bureau, there will be a good chance to bring the matter before the State Legislature at the next session, and that, in the light of a better understanding of the seriousness of the situation, success may this time be attained. It is understood that, with a few slight modifications, the Sutherland bill will meet the support of the producing interests, and that the incoming Governor, whoever he may be, will not be deaf to the 'S. O. S.' from the oilfields.

Public Utilities and Railroad Commission

Among the many precepts that we absorbed to a greater or lesser degree during our childhood days was the oft repeated warning to lay aside something for a 'rainy' day. Rain falls equally upon the just and the unjust, and makes no distinction between the individual on the one hand and the great corporation on the other.

Since the California Public Utilities Act went into effect and the Railroad Commission became its prophet, our preconceived ideas on many subjects, and among them the old adage anent the 'rainy' day, have received rude shocks. We are frankly puzzled as to the why and the wherefore, and being in a receptive mood, would like to be enlightened.

Assume, for instance, the existence of the X. Y. Z. Company, a good concern of its kind, if there be such things in these modern days of revelations. This Company is a public utility and is dispensing light and heat to the citizens of a large city. Having in mind the possibility of the occurrence of 'rainy' days, its board of directors, in the good old fashioned way, proceeded to provide for the accumulation of a sinking fund. The approved way to achieve this desirable end was, and still is, by charging rates sufficiently high to produce a surplus. Enter California Public Utilities Act and its prophet, the Railroad Commission. Behold, the community served was growing at a rate beyond the capacity of the Company to serve it. It was at once apparent that large capital expenditures would have to be made in order to increase the output and make the necessary extensions. Application in due form was then made to the Commission for permission to issue stock or bonds with which to provide the funds. During the course of the hearing it was developed that the Company was in the possession of a sinking fund of no mean proportions. Result, a scolding from the Commission, on the ground that the consumers had been unjustly taxed in order to produce the fund, and that further capital requirements should be obtained from the stockholders, through the gentle persuasion of assessments to be continued from time to time until the water has entirely disappeared.

This then appears to have been the situation. If the Company should expend its surplus for betterments, there would be no provision for the occurrence of the 'rainy' day. If the 'rainy' day should occur, and there should be no surplus, how could the Company raise money to carry it over the period of reduced earnings? Certainly not by selling more securities, as 'rainy' day markets and the sale of securities do not operate in parallel. Rates could not be increased for the same reason. If the Company, in an effort to cut expenses, should reduce its force, the service would suffer, and complaints be made to the Commission, which would read the riot act to the Company. What should the Company do under the circumstances? Attractive past dividends would also be taken as an indication that the rates charged were too high and that more capital should not be sought when a surplus already existed.

The chief objection to the issuance of more securities on the part of public utilities has been the admitted fact that all of them have more or less indulged in watering past issues. We must suffer for the sins of the past even unto the third and fourth generation, it is true, but is it quite fair to everybody to carry out this course? If by any process of law one could discover the original receiver of the unearned stock and make him disgorge, all well and good. But the purchaser in good faith and the present day community which is dependent upon the utility for service are being sufficiently punished for their sins and those of the past by being compelled to pay interest upon watered stock issues. Why not let the punishment stop there and see that no similar financial crimes are committed in future? Can a modern public utility be made a commercial success? With unattractive limitations of surplus and dividends, how can it finance to meet the demands of a growing business?

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REVIEW OF THE MONTH

USINESS affairs in the United States are gradually becoming readjusted to the new order of things. There is no more panic talk and commercial loans on approved security have been resumed. Crops are moving, so our good friend the farmer will reap the reward of the bountiful generosity of Nature for the season just passed. The destruction of the export market for American goods overnight was the most serious blow, nevertheless the American business man is a resourceful person, and steps are well under way toward conducting vigorous campaigns toward securing the other markets that, by reason of the paralysis of European competition, are awaiting us. The most serious handicap is the lack of capital. South American trade, for instance, is in the habit of doing business on long time credits. American foreign business has in the past almost invariably been transacted upon the basis of cash in full on presentation of bill of lading. Capital in large amounts must be provided if American merchants and manufacturers expect to do any great amount of business in South America, and a better acquaintance between American bankers and merchants on the one hand and the South American on the other must be accomplished if any permanent progress is to be made.

WHILE the importance of the chance to secure the South American markets for American goods is not to be minimized, yet the fact must not be lost sight of that Europe itself has been the most extensive customer America has had, especially for raw materials. The present condition of the cotton production of the Southern states is critical. Most of the cotton produced has been sent as raw material to England, Germany, and France, and returned to us in the form of manufactured goods. Cheap labor and low cost of living combined with a dense population is responsible for this economic incongruity, so we are facing a shortage of manufactured cotton cloth and an enormous superfluity of raw cotton. Conditions are so serious in the South that a strong movement is under way for obtaining a government subsidy in order that the situation may be temporarily relieved and industrial paralysis averted.

PETROLEUM producers in California, while not so badly off as the cotton growers of the South, are having their troubles. It is the loss of the export market again, and it is indeed tantalizing that gasoline and motor spirit, declared contraband of war, are practically unobtainable in Europe except by the military authorities, while in California gasoline may be bought retail at 12½ cents per gallon. While the refiner feels the stress of the present situation keenly, the producer of crude is even in a worse predicament. Those who have unexpired contracts are fortunate at the expense of the refiner, while those without contracts have no market for their product at all. However, let it not be forgotten that trade as well as Nature abhors a vacuum, and that by some hook or crook the export of petroleum products will be resumed before long. In the meantime rush orders for the construction of additional reservoirs and tankage do not hurt the feelings of the contractors, so it is an ill wind indeed that blows no one good.

THE total investment is placed by the Company at $26,553,667. Based upon an interest rate of 7 per cent on the above amount, to which the Company claims it is entitled, the loss per passenger is placed at 11.7 cents, thus producing a gross annual deficit of $2,236,-704.81. In the operations of large corporations, losses or gains achieved by various departments are often a matter of bookkeeping. To make each section individually profitable would be ideal, but cannot always be accomplished. It appears unfair and economically wrong that overland freight traffic, for instance, should have to make up a deficit incurred in the operation of suburban lines. On this basis, to which the Commission apparently assents, we have the spectacle of one man paying part of the other fellow's bill. But is not all business conducted somewhat on these lines? Bad accounts are one of the bugbears of the business manager. How are they taken care of? Simply by assessing this item as a part of overhead charges and adding it to the cost. Every man who pays his bills, therefore, pays part of the bills of the man who doesn't pay, whether it is in the purchase of a commutation ticket or a dozen eggs. This system may not be good economics, it may be unscientific, and it certainly appears unjust, but it works. And until some genius can tell us of a better way to get around this vexatious condition, we must continue in this path.

EXCELLENT progress is being made toward the completion of the two passenger steamers under construction for the Great Northern Pacific Steamship Company to inaugurate a new passenger run between San Francisco and Astoria, Oregon. When the new line commences operations, San Francisco will have another great trans-continental rail terminal, and the Pacific Northwest will be brought into even closer touch with its central and southern neighbors than before. It has been exceedingly interesting for those engaged in the problems of catering to the whims of the traveling public to watch developments on the Pa-

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cific coast. Not so very long ago, steamship travel between San Francisco and southern California was only undertaken as a last resort. The curtain of charity may be drawn over the passenger accommodations on the only steamers available, and in general this mode of travel was only used by those who were attracted by the cheaper fare and were willing to put up with the discomforts for the sake of the monetary saving. The Southern Pacific Company, to take care of the increasing traffic, put on a new train, the 'Owl Limited,' on a par with the finest trains in the United States. The success of this move was so great that another train of the same class, the 'Lark' was put on the Coast route, and both are taxed to their utmost to handle the traffic.

THEN came the *Yale* and the *Harvard*, real steamers this time, steam turbine driven, fast, clean, and comfortable. They make the run to Los Angeles in nearly as quick time as the fastest trains. Popularity was achieved almost overnight, and since they began operations patronage has been liberal. Nevertheless there has been, as far as casual observation can tell, no perceptible diminution in the regular rail traffic. Apparently more people travel, that is all. Business men of San Francisco and Los Angeles, many of whom have business affairs in both places, practically commute between the two cities. It is perfectly feasible for a business man to spend three days in a week in each place without discomfort if he should be so inclined, and the two cities are nearly 500 miles apart.

NOW it would appear that history is about to repeat itself with respect to the Pacific Northwest. The 'Shasta Limited,' a train that is as near perfection as it can be made, has been making the run between San Francisco and Portland in about 26 hours, a distance of nearly 800 miles. It is expected that the two new Northern Pacific liners will make the run to Astoria in practically the same time, making connection with a train at that point for Portland. Each steamer is to accommodate 450 first-class, 102 second-class, and 200 third-class passengers. A speed of 23 knots per hour is to be maintained for 24 hours. Those having a tendency toward *mal de mer* will be interested in learning that the vessels are fitted with rolling bilge keels which will add greatly to the comfort of the passengers. It is expected that the new line will commence operations on January 1, 1915, which will put the Northern Pacific in a position to bid for the Exposition traffic.

AS was to have been expected, the California Railroad Commission has denied the application of the Southern Pacific Company for an increase in commuter rates over the Company's suburban electric lines in Alameda county. Six grounds are given for the denial, in effect that the Company apportionment of its investment and expenses on the basis of passengers carried on main line and suburban service was erroneous; that many of the Company's lines were built for competitive purposes, and that the burdens for the unnecessary duplication of service should not fall upon the patrons; that the present patrons should not be called upon to bear the extra burdens of investments made with provision for the future; that no single unit of the transportation system should be considered separately, and that in passing upon the question, the earnings and financial condition of the entire property should be taken into account; that the present rate was voluntarily granted many years ago, and that on the strength of this rate many people made investments and built homes, therefore an increase would be in effect confiscatory; and that in many of the communities in which the Company is operating, franchises stipulating the present rates were solicited by the Company and accepted.

REFERENCE to the Construction News Summary indicates that business on the Pacific coast, as far as the contractor is concerned, is far from being at a standstill. This is especially true with regard to road construction, the more prosperous counties vying with one another in their effort to meet the present demand of farmers and colonists for adequate transportation facilities. The Sacramento County, California, project for county road improvements met with a temporary setback on October 16, when the proposal to issue bonds for county road improvements was defeated by a vote lacking the necessary two-thirds by only a few hundred. It has been stated that eleventh hour opposition developed on the part of real estate interests, on the ground that the issuance of the bonds would unduly increase the tax rate. This position is somewhat difficult to understand, as the primary object of good road construction is to attract newcomers, promote development of natural resources, and as a direct consequence increase the demand and value of real property. Sacramento county is one of the richest agricultural districts in California, and in addition possesses natural advantages in the way of water transportation and rail communication that are unsurpassed by any other district in the state. The city of Sacramento has shown a phenomenal growth during the past few years, and in view of conditions in Europe, the opening of the Panama canal, and the attractions offered to Eastern visitors by the Panama-Pacific Exposition, it would appear that the voters have made a mistake in judgment in not taking advantage of the psychological moment to put their best foot foremost. Nothing definite has as yet been announced as to how soon the county government will again present the project, but it is expected that early in the spring the voters will have another opportunity to express themselves on the question. With all that has been written and spoken on the subject of good roads, it is a question as to whether most people really appreciate how far-reaching is their effect and influence on the welfare of a community.

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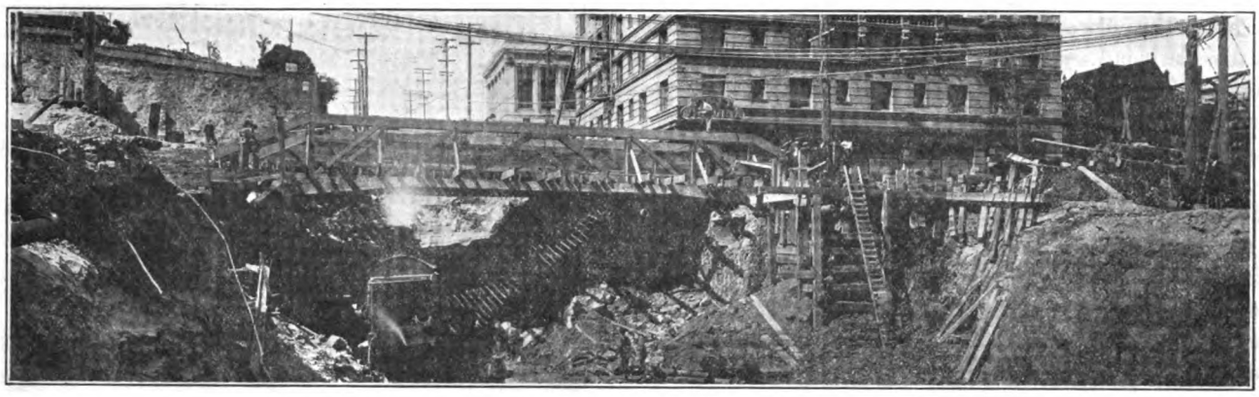

STEAM-SHOVEL AT WORK ON SUTTER STREET APPROACH, AUGUST 11, 1913.

Methods of Constructing the Stockton Street Tunnel, San Francisco.

By A. T. PARSONS

The Stockton Street tunnel was designed primarily to afford an additional avenue of communication between the North Beach district and the main business centre of San Francisco. The North Beach district, close to the centre of the city as far as actual distance is concerned, and covering an area of approximately forty city blocks, is almost completely cut off from the rest of the city by steep hills. Heretofore, it has had but two outlets giving practicable grades for transportation, one along the waterfront *via* the Embarcadero, the other between Telegraph and Nob hills *via* Kearny street. The first is too circuitous to be considered in reaching the centre of the city, and the second now carries more than its full share of traffic besides imposing a considerable extra distance on a large portion of it. The Stockton Street tunnel, when completed, will furnish an additional outlet two blocks farther west than Kearny street, with easy grades on each side for the entire distance.

The complete project, as will be seen from Fig. 7, extends from the north line of Sutter street to the south line of Sacramento street. The tunnel proper is driven from the south line of Bush street to a point 162 ft. south of the centre line of Sacramento street, the rest of the distance being open-cut approaches. From the beginning of the open cut at Sutter street to the north line of Bush street, the grade is 2.33%; from thence to Sacramento street, it is 4.29%. The

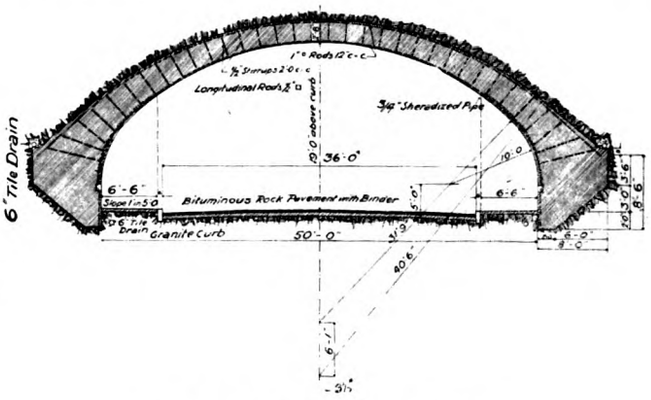

FIG. 8. STANDARD TUNNEL SECTION.

total length of the project is 1323 ft., and of the tunnel proper 911 feet.

The standard tunnel section is shown in Fig. 8. The arch gives a clear opening of 19 ft. at the centre and

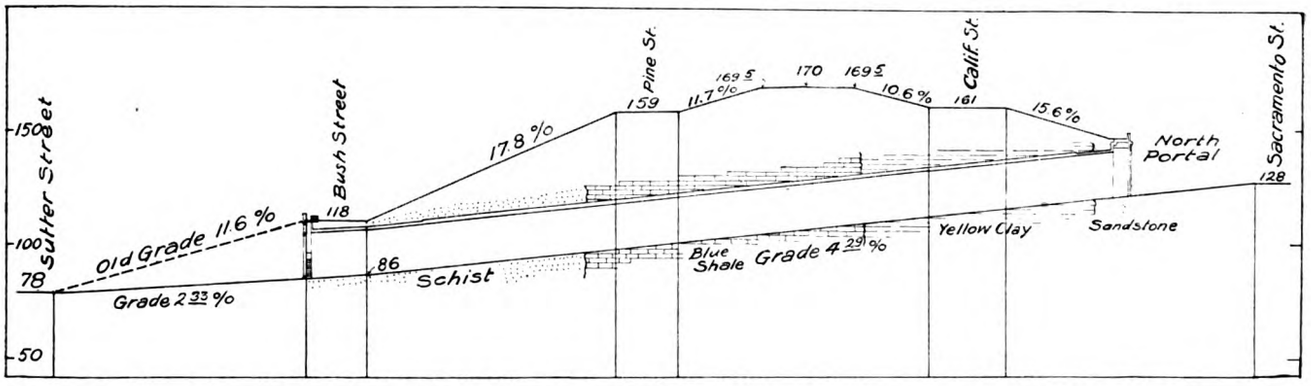

FIG. 7. PROFILE OF STOCKTON STREET TUNNEL, SHOWING FORMATIONS ENCOUNTERED.

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is 50 ft. wide. This gives room for 7-ft. sidewalks and a 36-ft. roadway. The new municipal double-track electric railroad *via* Stockton street to the Panama-Pacific Exposition grounds will be laid through the tunnel. The flat arch, the most novel feature of the design, was necessary in order to carry Bush street over the tunnel.

The tunnel lining is reinforced concrete, 8 ft. thick at the haunches, and 2 ft. 8 in. at the crown. The lining will run 18 cu. yd. of concrete and 1000 lb. of steel to the lineal foot. This section is considerably heavier than that called for by the original plans, because of the unstable character of the formation encountered.

Stairways are provided at each portal for the use of pedestrians, and several of the property-owners above the tunnel have been granted permission to construct elevator entrances to the tunnel. As will be

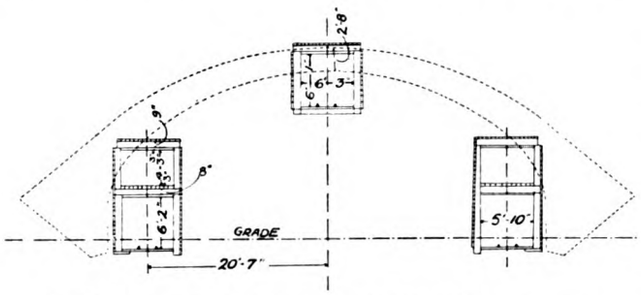

FIG. 9. LOCATION OF DRIFTS AT COMMENCEMENT OF WORK.

seen from the profile, the surface grades over the tunnel have been too steep for any great amount of vehicle traffic, and no provision has been made to enable vehicles to go from the ground above the tunnel to the tunnel grade.

The contract for the work was let to Jacobsen & Bade, of San Francisco. Actual construction commenced June 25, 1913, when a steam-shovel began work on the approaches. On November 1, 1913, drifts were started for the tunnel proper, and on June 25, 1914, the concrete lining was completed. The work of taking out the core began July 17 and was finished September 5. It is expected that the work will be completed, including laying the street-car track and pavement, about December 15.

As stated above, the approaches were taken out with a steam-shovel, the type used being a 20-ton Marion shovel with a 1-yd. dipper. On the completion of the approaches, three drifts were started in the tunnel, one at the top and one on either side of the tunnel, as shown in Fig. 9.

From surface indications, it had been supposed that the bulk of the material to be encountered would be fairly hard sandstone, but, in reality, very little sandstone was found, most of the excavation being in schist, slippery blue shale, and yellow clay. The classification shown on the profile should be considered as very approximate; in fact, pockets of the different materials were found throughout the tunnel. No

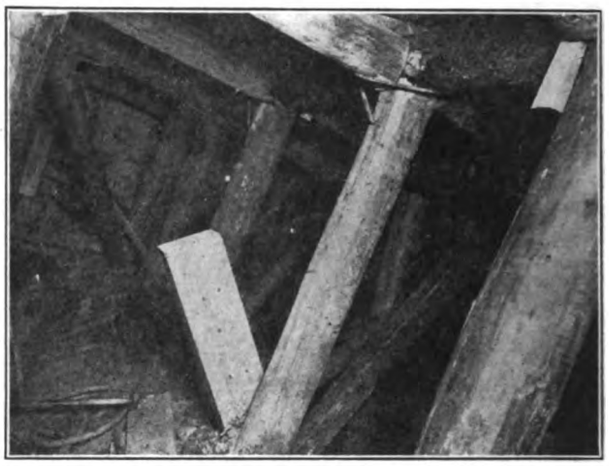

FIG. 10. METHOD OF TIMBERING SIDE DRIFT.

springs were encountered in the tunnel, but there was considerable seepage from water pipes and sewers above the tunnel. The latter were mainly large brick relics of the early days and were far from watertight. While this seepage was not heavy, probably never exceeding 100 gal. per minute, it was sufficient to permeate the entire mass of earth and rock above the tunnel and to add materially to the difficulties of the work. In addition, the winter of 1913-14, during which most of the tunnel lining was placed, was unusually wet. Because of water trouble, the bulk of the work was carried on from the southern or down-hill side.

The method of timbering the drifts is shown in Fig. 9, 10, and 11. Where blasting was necessary, drilling was done with air-drills mounted on columns, air being supplied by an Ingersoll-Rand, 16 by 18, two-stage compressor driven by a 200-hp. motor. The same compressor furnished air for ventilation, and also for the concrete transportation system, to be described later. Two 'upper' holes and two 'lifters' were used in the face of the drift. Six feet of hole was usually made at a time, this distance taking about two hours, on an average, to drill. Each hole was usually loaded with six sticks of 35% dynamite. Powder on the work cost from 6 to 10c. per cu. yd. of rock excavated.

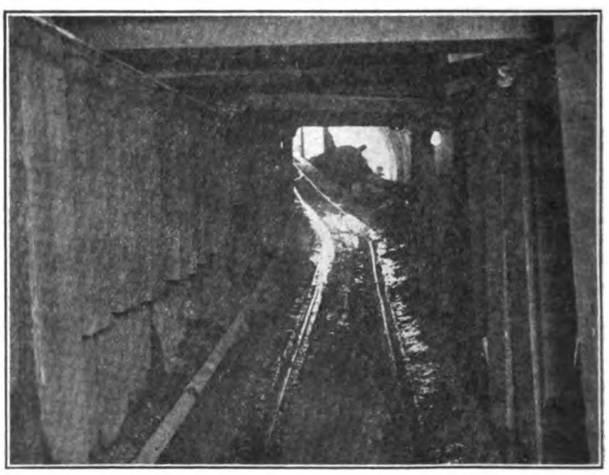

FIG. 11. METHOD OF TIMBERING END CORNER DRIFT.

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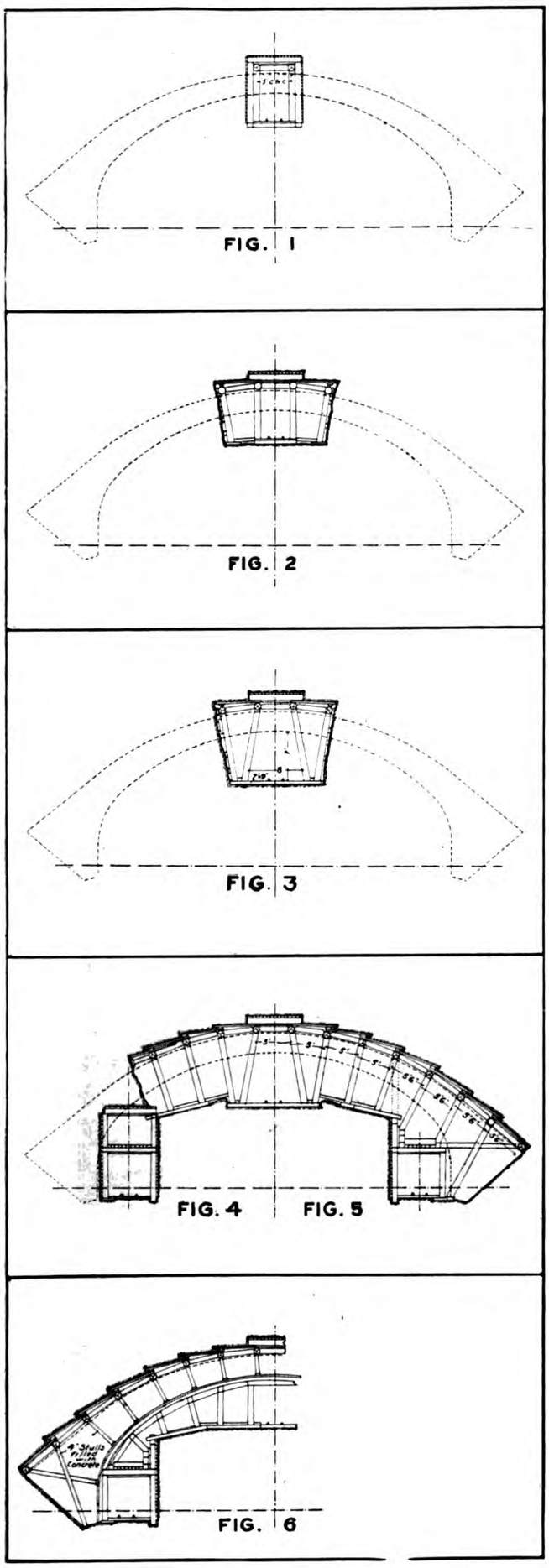

For enlarging the excavation to make ready for the lining, the 'crownbar' system, illustrated in Fig. 1 to 6, was used. Crownbars were of round fir, not less than 10 in. diameter, the minimum length being 20 ft. They were selected of differing lengths, and wherever possible placed to break joints. All lagging was 3 in. thick, and the posts supporting the crownbars were either square or round timbers not less than 10 in. diameter or on a side. The first operation in enlarging the excavation is shown in detail in Fig. 1, and consisted in lowering the floor of the drift at the top of the tunnel and placing the first crownbars. In the second and third operations, shown in Fig. 2 and 3, the top drift was further enlarged and additional crownbars were placed. In the fourth operation, Fig. 4, the top drift and the side drifts were connected, and in the fifth operation the abutment was excavated. Fig. 6 shows the sixth operation completed, with the entire excavation for the arch removed and ready for the placing of the concrete, the forms being supported on the still unremoved core.

In this way, the excavation for the arch was completed successfully with a minimum of damage to surrounding structures. The only building which sustained any appreciable damage was that of the Metropolitan Life Insurance Company on the summit of the hill between Pine and California streets. At this point, where the greatest depth of material overlaid the tunnel arch, the entire surface of the street settled an average of 16 in., causing a number of cracks in the walls of the building.

A 15-ton Marion shovel of the revolving or 'merry-go-round' type, with a ⅝-cu. yd. dipper, was used for the removal of the tunnel core. The actual cost of excavating the core, exclusive of all overhead and plant charges, was $1.18 per cu. yd., of which 52c. was for the excavation proper and hauling to the delivery chute, and 66c. contract price to the trucking company for hauling the material to the dumps. The actual labor of excavating the drifts was sublet to 'stationmen' for $3.50 per lin. ft., or approximately $1.70 per cu. yd. This did not include furnishing and delivering powder, tools, timber, light and power, nor the removal of the excavated material from the mouth of the tunnel, all of which was done by the contractor. The most expensive excavation, however, was that for the arch lining after the drifts were complete. In all, approximately 2,500,000 ft. of lumber was used, including forms for concrete, and only a small part of this could be salvaged, the bulk of the timber having to be left in the tunnel. The total excavation was approximately 67,000 cu. yd., and the average cost to the contractor $4 per cubic yard.

A 1:2:5 concrete mixture was used of Santa Cruz portland cement, sand, and rock. The surface was finished with a 1:2 coat of cement and sand and a finishing coat of Medusa plaster. The mixer was placed at the Sutter Street level and all the concrete work handled from that end of the tunnel. The

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bunkers were placed at the Bush Street level and materials were delivered by a chute to the mixer. A 1-cu. yd. Foote mixer was used, driven by a 15-hp. electric motor.

From the mixer, the concrete was dumped into a steel tank, from which it was conveyed by compressed air to the forms. A 4-in. air-pipe and an 8-in. discharge pipe for the concrete were used. One hundred twenty-five pounds pressure was employed, and the greatest distance transported was slightly over 1000 ft., including a lift of about 90 ft. With this system, 1 cu. yd. of concrete could be moved in 2 minutes, and no difficulty was experienced at any time in keeping up with the regular output of the mixer, 160 cu. yd. in 8 hours.

There was considerable labor expense involved in moving the discharge pipe from one delivery point to another. The wear on the pipe was heavy, the life of the ells and other specials averaging about 60 hours' actual service, or 1200 cu. yd. of concrete transported. Straight pipe experienced but little wear except near the couplings, where, if the pipe was not absolutely straight, it was frequently necessary to recut the pipe and threads.

This method of concrete transportation is a patented process. The total cost for royalty, power, and labor averaged $2.25 per cu. yd. The average cost for forms was $1.25 per cu. yd., making a total cost for concrete, exclusive of materials, of $3.50 per cu. yd. The concrete gang was composed of one foreman, six men on the mixer, and four men at the delivery point.

Excavated material from the tunnel was hauled out on the trestle shown in Fig. 12, and dumped on the trucks. The height of the trestle above the street-level was about 15 ft., and as the grade of approach rises toward the tunnel on that end, the grade on the trestle was nominal. A train of eight 1¼-cu. yd. side-dump cars was hauled by a 35-hp. electric locomotive.

FIG. 13. OPEN-CUT WORK IN FRONT OF COLONIAL HOTEL.

All hauling outside the tunnel, both the delivery of the concrete materials and the removal of the excavated material, was done by J. P. Holland, over an average distance of two miles. Five-ton auto-trucks were used, carrying an average of 4 cu. yd. to the load. An average of ten round trips per 8-hour day was made. Detailed costs of operation are not at the present time available, but it is known that the contract price for removal of the excavated material was 66c. per cu. yd. Using this figure as a basis and assuming 4 cu. yd. and 5 tons hauled per load, the cost is 33c. per cu. yd. mile, and $0.528 per ton and $0.264 per ton mile.

The cost of the tunnel was met by a graduated scale of assessments on the property benefited at both ends of the tunnel, $616,528 being raised by two assessments. Of this amount, approximately $400,000 will represent the actual cost of the work, the balance being damages to property-owners affected.

The writer wishes to acknowledge his indebtedness to Mr. Fitzgerald, of the City Engineer's office, and Mr. Bade, of Jacobsen & Bade, the contractors, for much data and other assistance in the preparation of this article.

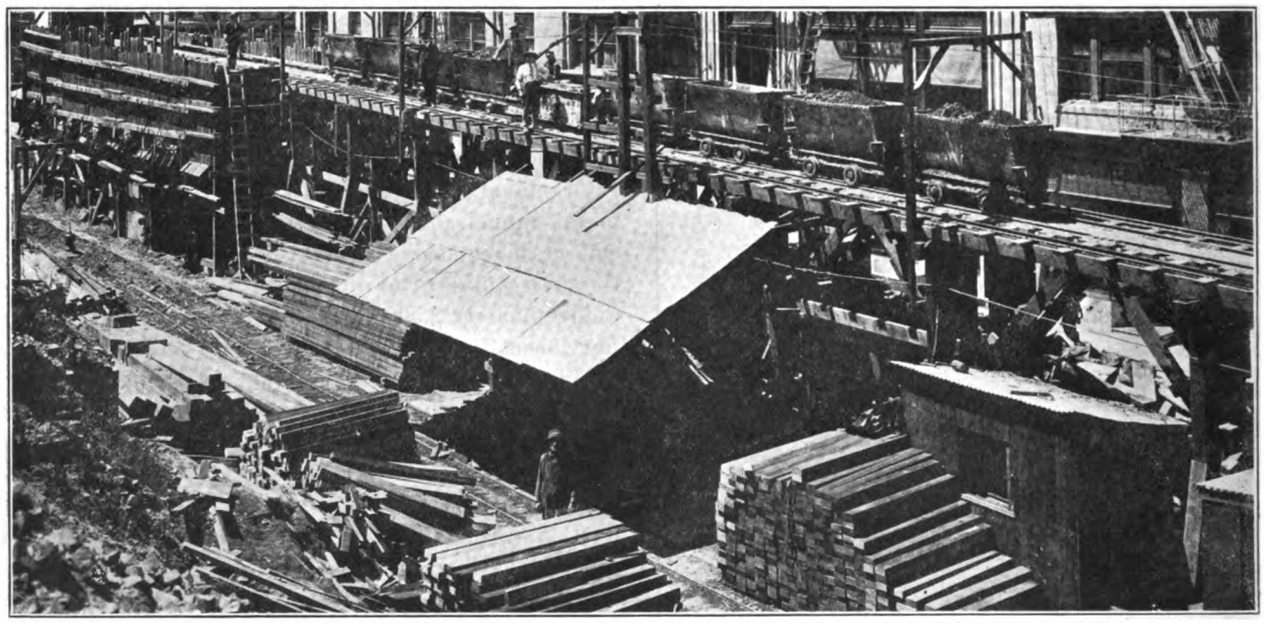

FIG. 12. HAULING EXCAVATED MATERIAL FROM TUNNEL WITH ELECTRIC LOCOMOTIVE AND SIDE-DUMP CARS.

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Factors Controlling the Durability of Concrete in Sea Water

By FREDERICK W. HUBER*

The behavior of concrete in sea water has been a fruitful though not altogether profitable source of discussion for the past seventy years. On the one hand there are those who contend that concrete properly made and placed to suit the conditions is the ideal material for marine structures; on the other hand, there are those who point to a few cases of failure as incontrovertible proof that concrete cannot withstand the action of sea water. The contention of the first faction has the many thousand successful structures to fall back upon, while the second has only an almost negligible percentage of failures with which to prove its assertion.

Chemistry of the Action of Sea Water Upon Portland Cement

In those instances in which portland cement concrete has failed in sea water, the chemical analyses have invariably disclosed a high percentage of magnesia, often amounting to 30% of the total original lime present as cement. This has led some engineers to the unwarranted conclusion that magnesia was the destructive element in portland cement. Every one thousand parts of sea water contain about 34.4 parts by weight of mineral matter in solution. This mineral matter has the following composition:

	Per cent.		Per cent.
Sodium chloride	77.75	Calcium sulphate	3.60
Magnesium chloride	10.87	Potassium sulphate	2.46
Magnesium sulphate	4.73	Other salts	0.56

Now, it is well known that when portland cement hardens, calcium hydrate separates and is partly adsorbed by the colloidal silica of the cement, forming the mineral glue to which portland cement owes its peculiar properties. A portion of this calcium hydrate, however, does not combine chemically, but crystallizes and is subsequently converted into calcium carbonate by absorption of carbonic acid from the air. If this hardening takes place in the presence of magnesium chloride or sulphate, the following reactions will take place:

(1) $Ca(OH)_2 + MgCl_2 = CaCl_2 + Mg(OH)_2$

(2) $Ca(OH)_2 + MgSO_4 = CaSO_4 + Mg(OH)_2$

In equation (1) we have on the right the formation of very soluble calcium chloride and relatively insoluble magnesium hydrate, so that the soluble lime chloride is leached out and insoluble magnesium hydrate left in its place. This, then, accounts for the accumulation of magnesia found in sea water disintegrated concrete.

In equation (2) we have two insoluble (or nearly so) compounds formed, *i.e.*, calcium sulphate and magnesium hydrate. From a purely chemical standpoint the formation of this calcium sulphate brings about a very interesting reaction, which has been, until very recently, considered the 'real' cause of disintegration. A sulpho-aluminate of lime is formed, which crystallizes with 120 molecules of water, undergoing, of course, a large increase in volume. Chandlot gave to this compound the formula:

$$2(Al_2O_3 \cdot 3CaO)(5CaOSO_3) \cdot 120H_2O$$

it being apparently a double salt of tri-calcium aluminate and calcium sulphate. The peculiarities of this compound certainly offered a very plausible explanation of disintegration in sea water. There can be no question about the existence of such a salt, but the researches of Rubuffat have shown that the compound cannot form in the presence of sodium chloride (common salt). Its formation in concrete submerged in sea water, or even moistened with it, is therefore highly improbable. The discovery of this salt immediately shifted the responsibility for disintegration from magnesia to alumina. Marine constructors therefore demanded for a time low alumina cements until experience showed that they were not immune. Sulphuric anhydride then in turn became the scapegoat until 1912, when the International Association for Testing Materials Congress made the recommendation that the allowable percentage of sulphuric anhydride of cements for all purposes be raised from 1.75% to 2.5%, thus acquitting sulphuric anhydride.

Chemistry, then, has been unable to satisfactorily explain the decomposing action of sea water upon portland cement concrete. The contention of the old school of chemists that portland cement concrete must of necessity undergo progressive disintegration in sea water is contradicted by more than fifty years of practical experience in marine structures, which were constructed with carefully selected aggregates accurately and scientifically manipulated.

The slow progress made in the past toward the solution of the problem was due directly to the mental attitude of the engineers. Failures that did occur were not completely analyzed. Invariably the cause was sought in a possible chemical action; little or no attention was paid to the other contributing factors.

If the percentage of failures of concrete structures on land be compared with those taking place in sea water, it will be found that the percentage of the first is perhaps the larger; yet no one would, as the result of the occasional failure of concrete on land, condemn the use of the material generally for such structures. Without exception, such failures have upon analysis proved the necessity for closer attention to the essential details of proportioning, mixing, and placing. As-

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suming now that there are as many errors of omission and commission made in the construction of sea-water structures as there are in structures on land, would it not seem reasonable to explain the occasional failure of a concrete structure in sea water by the lack of attention to essential details, rather than attribute them to causes of a more widespread and general nature?

Impermeability and Its Relation to Resistance to the Action of Sea Water

The impermeability of a concrete is dependent upon, 1, the proportion of cement, sand, and coarse aggregate, and, 2, the amount of water used in mixing.

1.—The density of the concrete will depend upon the size of the sand grains being such as to fit the voids of the coarse aggregate, and upon the voids in the sand being **more than filled by cement in the plastic state.** The density of the sand-cement mortar, then, is the controlling factor.

2.—In order that the various sizes of aggregate arrange themselves in the most compact manner, there must be present sufficient water to act as a **lubricant** to permit the particles to 'slide' readily into place. This amount of water is also that necessary for the proper hardening of the cement in setting up. This principle is well illustrated by some tests made by Bamber (*Proc.* Inst. C. E., Vol. CVLL, 1891) in connection with an analysis of the Aberdeen Dock failure (1887). Mr. Bamber made up three sets of blocks in duplicate with a 1:2:4 concrete, using three degrees of consistence; *i.e.*, 1, plastic; 2, slightly wet; and 3, moist. All blocks were hardened in air for two weeks, after which three sets were placed on a sea-wall and left to the changes in tide for one year, after which they were broken and the interior examined. The duplicate series was placed in separate receptacles filled with fresh clear water and left for one year, after which they were broken and the interior examined.

Conditions of the Blocks Exposed to Sea Water One Year

No. 1 (plastic)—Block hard, perfectly sound, and dry on interior.

No. 2 (semi-wet)—Block dry in centre, but water had penetrated 3 in. in from surface; concrete in fair condition.

No. 3 (moist)—Wet throughout whole interior and softened on surface.

Conditions of Blocks Immersed in Fresh Water for One Year

No. 1 (plastic)—The block was sound, dry on interior. The water in vessel remained clear.

No. 2 (semi-wet)—The block was sound; moisture had penetrated some distance into the mass. The water in vessel was turbid.

No. 3 (moist)—The water was very turbid. At the end of one year the block was covered with a coating of lime hydrate crystals ¼ in. thick, showing that the lime hydrate had been leached out and crystallized on the surface.

These tests illustrate very clearly the necessity for proper manipulation. All of the test pieces were of the same proportions, the only variation being the amount of water used. It would appear, therefore, that rich mixtures alone, without the proper amount of water, will not insure success. These tests throw much light upon the causes of failures of concrete in sea water.

Two Notable Failures

The two failures of concrete in sea water most quoted as an argument against the use of concrete for various structures are the failure of the entrance walls to the graving dock at Aberdeen, Scotland, in 1887, and the failure of a sea-wall at the Charleston navy yard, Boston harbor, in 1907. The facts in connection with these two failures will be considered at length.

The Aberdeen Failure

The graving dock at Aberdeen was opened in 1885, and as early as 1887 the entrance walls showed marked signs of disintegration. The following details of construction are given by Cunningham ('Treatise on the Principles and Practices of Dock Engineering,' p. 125):

"These walls were built as a homogeneous mass of concrete, deposited inside frames, composed of *1 part portland cement, 2 parts sand, 3 parts stone* for one-third of the depth of the frame and of *1 part portland cement, 3 parts sand, and 4 parts stone* in the upper two-thirds of the frame. It had also been intended to provide the wall with a facing of 2 parts cement, 3 parts sand, and 4 parts stone, but this was omitted and the surface was plastered instead. The sand used was clean sharp quartzose, and screened through a sieve of 40 meshes per linear inch.

"Shortly after the opening of the docks in 1885, signs of disruption appeared, and in 1887 Mr. Wm. Smith, the engineer at that period, reported that the entrance walls had expanded 2¾ in. on the height of the walls, and the surface had cracked and bulged."

Numerous chemical analyses were made of the disintegrated portion of concrete, from which Cunningham draws the following conclusions:

"1. That the cement actually used in the construction of those portions of the wall in which decay occurred might have been of different composition and inferior quality to that of the original test briquettes.

"2. That the aggregate must have been (to judge from the analyses) impregnated with material of an argillaceous nature.

"3. That the sand was much too fine for the purpose of making concrete and was used in excessive quantities. A 40-mesh sieve for sifting sand is absurdly fine. According to Messant's report, the deterioration was confined (so far as could be ascertained by examination) to the concrete which contained the largest proportion of sand, *i.e.*, 1:3 and upward." Supplementary evidence is given by Leedham (*Proc.* Inst. C. E., Vol. CVII, p. 109.)

"Twenty years ago he had been at Aberdeen and had examined one of the concrete blocks made at the beginning of that particular work. The block was pointed out to him as not giving satisfaction to the engineer, and that although it had been made several weeks, he had no difficulty in crumbling off a piece with his hand, part of which he took home and

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washed, which disclosed that the sand which had been used so liberally was so minute that it was little better than dust."

At a later date more evidence was offered by Bamber (*Proc.* Inst. C. E., Vol. CVII). In commenting on the cause of the Aberdeen failure, he says:

"There could be no doubt as to the cause of the failure. In the first place, the original dry cement contained, by analysis, 8.18% carbonate of lime and 11.20% hydrate of lime, showing that the cement had never been properly burned, or that it had been spoiled by exposure to the weather. How any engineer could use such a cement, knowing its composition, was beyond all understanding. If the analysis was omitted until after the work was completed, then the precautions required in such large work was neglected. Again it appears that undue economy was used in working the cement into concrete. But cement of such composition would be useless in such or any proportions."

The evidence presented can leave no doubt as to where the responsibility for the failure must be placed. The leanness of the mixture, the extreme fineness of the sand, and the questionable quality of the cement, could each alone have produced the effect. Apparently nothing was omitted to make the conditions for a total and spectacular failure propitious.

The Failure of the Charlestown Navy Yard Dock

One of the quay walls of the Charlestown navy yard, Boston harbor, was found in 1908 to have disintegrated between the low and high water marks to a depth of about 8 in. after a few years' service. In commenting on this failure, *Engineering News* (Vol. 60, No. 9, p. 238), in an editorial, makes the following observations:

"The government authorities on the work have no explanation to make of the cause of the disintegration, merely giving the facts in the case. It is well to note, however, that the decomposition occurred in probably a porous concrete, as it was mixed and laid 'dry' with no special effort toward density or waterproofing, and that the structure is in a tidal sea water subjected to alternate freezing and thawing, and finally that the decomposition is confined between the high and low-water levels."

In reply to the above, M. O. Tuttle, of the Aberthaw Construction Co., of Boston, made some very pertinent observations (*Eng. News*, Vol. 60, No. 13, pp. 341-342), as follows:

"1. All the cases of disintegration observed by him during an experience extending over ten years can be as readily explained by frost action as by the chemical decomposition of the concrete.

"2. That in tidal waters an exposure of only a few hours will, at low temperature, freeze several inches into any masonry. This alternate wetting and drying is necessarily only found in salt water bodies (*i. e.*, tidal). Under the action of frost it would be difficult to conceive any effect other than spalling of the masonry.

"3. The so-called 'disintegration' of concrete in sea water, he believes, is nothing more than spalling in all directions, due to the absence of 'grain' as compared to natural stone.

"4. An examination of the concrete in the Charleston docks showed hard spots of concrete unaffected by the action inside of the tidal zone. These hard spots were found, on examination, to be composed of *very dense* concrete in which the aggregate was very well graded. In all the decomposed portions, however, grading was very poor, being composed mostly of sand without any coarse material.

"5. He calls attention to the necessity of making impermeable and dense concrete for sea-water structures."

In reply to Mr. Tuttle's observations, *Engineering News* (Vol. 60, No. 17, p. 453) makes the following editorial observations:

"It is the daily range of tide resulting in constant freezing and thawing at low temperatures that is the controlling factor in causing decomposition, and the fact that the water is salt instead of fresh has nothing to do with it. Concrete exposed in any other way so as to be alternately wet and dry at frequent intervals at low temperatures might be expected to 'disintegrate' in a similar manner."

The two failures above quoted have been declared by unimpeachable authority to be due to errors of proportioning, mixing, and placing. A very significant fact in connection with the Aberdeen harbor that should be mentioned is that this graving dock is only one of the many concrete structures built in that harbor. The balance of the structures built at a later date and under better specifications are at the present time in an excellent state of preservation.

In the Charlestown failure the other structures built at an **earlier date** are in excellent condition.

It may be stated generally that in all cases where disintegration has taken place there are other structures in the immediate vicinity and in the same environment that do not show any evidence of deterioration.

Concrete Blocks for Sea-Water Construction

As early as 1865, constructors realized that the deposition of concrete *en masse* under sea water was attended with considerable risk as to the ultimate outcome. They had also made the observation that concrete hardened in air and then deposited into the sea gave uniformly good results. Accordingly concrete blocks of suitable dimensions were resorted to. One of the first applications of this method of construction was made at Dublin in 1872, where a quay wall 3200 ft. in length and standing 10 ft. above high tide mark was constructed of blocks made and hardened on land, the largest of which weighed 350 tons.

Similar construction followed in the harbors of Cork, Hurracho, Columbo, St. Heilers, Bongie, Suez, between 1878 and 1888, and all of these are today in excellent condition.

In 1896 there was completed the Russian military harbor of Libau on the Baltic. The walls and breakwater are constructed entirely of concrete blocks weighing from 20 to 30 tons. The maximum depth below low tide is 30 ft. The total length of the work is 19,700 ft., and in its construction 420,000 bbl. of portland cement was used. (See *Proc.* Inst C. E., Vol. CXXVI.) This particular piece of work is considered the largest of the kind ever built. It is mentioned as an example of the confidence placed in concrete for sea-water construction by large constructors.

At the International Engineering Congress, 1904

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(See *Trans.* Am. Soc. C. E., 1904), I Hiroi of Tokyo, Japan, read a paper on 'Concrete Blocks for Harbor Work,' in which he makes the following observation:

"Of over 12,000 concrete blocks examined after ten years' exposure in harbor work, there has been not the slightest sign of deterioration, but disclosed the concrete to be in better shape than when first put in.

"The most important factor in insuring the durability of the blocks in sea water is the *mode of fabrication.* Most failures of concrete blocks in sea water result from the lack of proper attention to some of the important details. Apart from the good quality of the aggregate, without which good concrete is impossible, the most important point in making concrete is to *make it dense.*

"It is but little more than 70 years since cement began to be used for sea-water construction, and sufficient time has not elapsed to prove or disprove the various claims for it. Meanwhile its faultless behavior up to the present time, whenever it has been used with properly due attention to all the essential details, speaks for its value to produce materials which will outlast those of nature."

Similar examples of concrete blocks in construction and their success could be multiplied indefinitely. The examples presented have been cited, not as an argument in favor of this particular form of construction, but to emphasize the necessity for properly prepared and cured concrete.

Concrete Construction in San Francisco Harbor

Recently there has been appropriated for the harbor of San Francisco, for the improvement of the docks and waterfront, the sum of $8,000,000, which will be spent largely in replacing wooden wharves with those of reinforced concrete. This harbor today furnishes examples of nearly every type of concrete construction, some of which have proved failures, while others have been conspicuous successes. The case of pier No. 5, built in 1908, is perhaps the most notorious. The construction in this case consisted of cylindrical caissons built of redwood which were sunk into place, but not pumped out. Into these the concrete was deposited by simply dumping into the water-filled forms. At the end of eighteen months the wooden envelope was eaten away and the piers crumbled to pieces. An examination made at this time disclosed the concrete, so called, to be made up of segregated layers of stone, sand, and cement. A case similar to this is that of the Long Beach pier. Both of these failures are commented upon editorially in the *Engineering News* of July 21, 1910, p. 78, viz.:

"Attention is called to a practice (of depositing concrete under water) that has had some vogue in the past, particularly on the Pacific coast. We refer to the practice of building concrete piers of small piles in water by depositing the concrete inside wooden forms, from which the water cannot or is not pumped out. In two places along the Pacific coast, at Long Beach and some wharves in San Francisco, where in the course of a year or so the wooden coverings have rotted away, it has been found that the structure of the concrete in the piles was of extremely poor quality. At any rate, whether due to unpreventable structural causes or to carelessness in construction fathered by the known fact that thorough inspection is impossible, at least separate piers founded on concrete piles of this nature have proved unsatisfactory, and in each case the type of failure was practically the same. This is sufficient to condemn the method.

"There are so many other ways of placing concrete piles that it is hardly worth while to risk failure by this scheme in order to effect a possible economy."

The most notable structures recently undertaken in San Francisco harbor are piers 38 and 40, in which the entire structure is of reinforced concrete, including piles and superstructure. At the present time the Harbor Board is replacing all decayed wooden bearing piles with 16 by 16-in. reinforced concrete which are driven by a water jet.

The present specifications for concrete under which all work is being done are exemplary. The proportion of cement to aggregate is limited to 1:5, in which the aggregate must be so graded as to produce the densest mass. This will give, as a rule, a proportion of 1 cement, 1¾ sand, and 3¼ rock.

Just recently the underpinning of slips 3, 4, and 5 of the Ferry building have been replaced by concrete piles surmounted by a 6 by 6-ft. pier.

On Alcatraz island in San Francisco bay there is an old foundation of concrete built in 1867 which is daily covered and uncovered by the tides. The concrete shows no signs of having suffered any disintegration.

The outfall sewer of the city of Oakland which enters the bay just off the Key Route mole is five years old. The combined action of the sewage and sea water has as yet made no attack upon it. If chemical action amounts to anything it could be reasonably expected that the sewage and sea water would have attacked this structure in a very short time.

Recent Examples of Reinforced Concrete Piles and Docks in England

Within the past 12 years the improvements in harbors in England have aggregated $200,000,000. Almost without exception all of these improvements in docks have been made with reinforced concrete construction. The use of reinforced concrete piles has been particularly extensive. At Southhampton the Southwestern railway has built six docks, all of which are reinforced concrete superstructures resting on reinforced concrete piles. The first of these docks was built ten years ago, and at the end of eight years showed signs of disintegration above the low-water mark. At first it was believed that the vibration of the coal handling machinery was the cause of this effect, and that the structure was too light. An examination by the British Concrete Institute in 1910 showed this effect to be due to electrolysis, caused by leakage in the wiring on the dock. The docks built subsequently were improved upon in details and rigidity and have given perfect satisfaction. The Thorneycroft jetty, which lies directly opposite the first mentioned dock, has been in service for 12 years and is in perfect condition, as is also the Woolstone dock built at the same time.

The confidence in reinforced concrete construction

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for tidal harbors displayed by the British engineers is strikingly exemplified in the magnitude of the projects completed at Swansea, Port Talbot, Ipswich, Gravesend, Manchester, Dagenham, and Parkestown. That the confidence of the American engineers in reinforced concrete is unshaken is shown by the largely increasing use of it for harbor improvements. Such projects as the Key West viaduct of the Florida Key West railroad, the Galveston sea-wall, the entrance walls of the Panama canal, the harbor improvements in Manila and Pearl harbor, the stupendous improvements under way at Bahia Blanca, Argentine, and Kobe, Japan, speak eloquently of the confidence placed in the material.

The excellent results attending the use of reinforced concrete in New York and Baltimore harbors, the waters of which are highly polluted with sewage, have discredited the theory that sea water decomposes properly made portland cement concrete. If chemical decomposition of properly made concrete amounts to anything, these harbors would be the first to show it.

Finally, the recent sea water tests on full sized test pieces reported by the Scandinavian authorities (See *Concrete & Constructional Engineer*, 1910, p. 23) have confirmed the fact, long established by practical experience, that the decomposition of concrete in sea water is not chemical but mechanical, and that the resistance of concrete to the action is a matter of proper proportioning and manipulation of the materials to produce a dense mass, which must be thoroughly hardened before being exposed to the action of sea waters.

Remedies Proposed to Improve Portland Cement for Use in Sea Water

In view of all the authoritative tests that have been conducted in Europe and the United States during the past ten years, we may safely state that portland cement, by itself, needs not to be improved for use in sea water. The improvement must take place entirely in the making of the concrete. In short, it is not a question of better cement, but of better concrete. Perhaps the most comprehensive series of tests upon the action of sea water upon concrete are those instituted by the Scandinavian Association of Portland Cement Manufacturers coöperating with the harbor authorities. These tests are entitled to careful consideration, inasmuch as they were carried out on a large scale under very severe conditions.

The test pieces consisted of large blocks 2 by 4 ft., exposed to the rise and fall of the tide, frost, and atmospheric influences at a number of localities on the Baltic sea and the coast of Jutland. The result of the ten years' tests have just recently become available. These tests were made with portland cement with additions of trass, infusorial earth, santorian earth, puzzolane, slag, and fine sand, mixed and ground with the cement. The conclusions so far as they are possible to be drawn from the ten years' exposure may be summarized as follows:

Much depends upon the compactness of the mortar. A loose mortar, by allowing salts to penetrate to the interior of the mass, is rapidly disintegrated. A rich mortar must be used. A mortar consisting of one part of cement to three parts of sand is not rich enough, as the majority of the one-to-three mortars disintegrated, while the one-to-two mortars did not. Any good portland cement not excessively high in alumina appears to be suitable for sea construction.

The main agency of destruction is not chemical, but is due to the alternate saturation, drying, freezing, etc. The destruction takes place sometimes by cracking, sometimes by scaling, and sometimes by softening. The addition of finely ground silicious material is of doubtful value. The addition of an infusorial earth gives very inferior results.

The destructive action of the sea being mainly physical and mechanical and not chemical, tests by mere immersion in still sea water are of very little value in determining the behavior of a concrete in massive engineering work. A mixture which disintegrates under these tests is certainly useless, but a mixture which passes this test may disintegrate under more stringent conditions of practical usage. As long a period as practical should be allowed for the hardening of the concrete in air before placing in the sea.

From the many successful structures that are today resisting the action of sea water, coupled with exhaustive researches made into the effect of sea water upon concrete, there seems to be no room for a reasonable doubt that the success of concrete in sea water is dependent principally upon better concrete rather than any modification of the chemical composition of the cement to be used.

EFFICIENCY OF DIESEL ENGINES

Some tests undertaken at the Royal Technical college, Glasgow, to ascertain the effect of variation of blast pressure and of jacket-water temperature on the efficiency of Diesel engines were described in a paper read at Newcastle by Walter S. Burns. As regards blast pressure, he concluded that, at light loads, the excess air already in the cylinder, and the inrush of blast air with the small quantity of oil, cause late ignition and slow combustion of the fuel. Then as the load increases, and the mixture of pulverized fuel and air becomes richer, there is a correspondingly earlier ignition, and also an increase in the rate of propagation of the explosion. At all loads, too low a blast pressure pulverizes the oil imperfectly, causing late ignition and incomplete combustion, with increase of exhaust pressure and temperature above normal, while too high a blast pressure causes late but violent ignition, attended again by incomplete combustion of the oil. His conclusion as regards jacket-water temperature is that at all loads increase does not seem to affect the point of ignition of the oil appreciably, but causes more rapid and more complete combustion with increased efficiency.

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FIG. 1. DONKEY ENGINE ANCHORED IN POSITION FOR PULLING STUMPS.

Use of Logging Equipment for Clearing Land of Stumps

By H. P. JACOBSEN*

During the year 1912 and the first half of 1913, considerable land clearing was done near Bear river, in the Sacramento valley. The operations were such that a total of 10,109 acres was cleared in a period of 14 months. Rapidity of movement in operation was necessary, in view of the fact that the bottom lands were being cleared and prepared for early sowing.

This bottom land was covered with undergrowth and cottonwood, willow, and other trees that live along the river bottoms. In view of the fact that the largest of trees found in these river bottoms measured over 4 ft. in diameter, it became necessary to consider means other than dynamiting. An operation which not only pulled the stumps, but also hauled them to piles where they could be disposed of by fire, brought into use the modern stump-pulling donkey engine. This engine is so powerful that the largest stump can be taken out in less than one minute, and is known as a special geared compound yarding engine, used in logging operations in the lumber camps, consisting of an upright boiler 96 in. high and 44 in. diameter. Speed of drums is approximately 50 ft. per minute of rope travel and a 25-ton pull.

The engine is mounted on a large sled or skid 40 ft. long, and of such a character as to enable the engine to pull itself over the field in which it is operated. A distance of 1500 ft. can be cleared without moving the engine. In clearing bottom lands, no expense is occasioned for fuel, as more or less stumpage can be used for this purpose.

In order that the reader may secure an idea of the manner of operation, a diagram is shown, outlining equipment when in use. It will be noted that two wire ropes are needed, one the main or pulling line, and the other the haul-back line for returning the main line back to point for extracting the stump.

When undertaking to rid land of stumps for either agricultural purposes or with the idea of obtaining earth for levees or improvements, it is desirable first to chop out all small underbrush and to fell all trees at a height of about 3 ft. from the ground, thus getting rid of all branches and other rubbish. The bare logs cut may be left where they fall until the proper time approaches for yarding them to the burning pile. As shown in Fig. 1, the engine is anchored and a main line run out a distance of about 1200 ft., this main line being attached to what is known as the haul-back line. The haul-back line runs through three haul-back blocks, as shown in Fig. 8. These haul-back blocks have 10-in. sheaves with extra large pins. At the end of the main line are attached two 2½-in. line hooks for the purpose of hooking to 'chokers,' which are wire ropes varying in length from 10 to 20 ft. with a hook in one end and a loop in the other.

*72 Fremont street, San Francisco.

FIG. 2. LINE OF STUMPS BEING UPROOTED BY DONKEY ENGINE.

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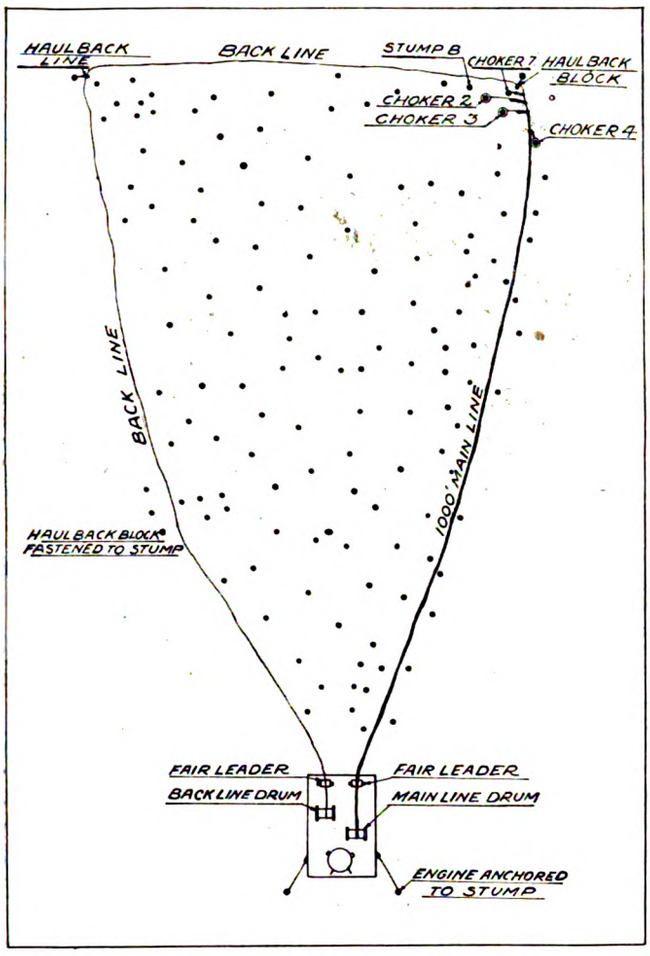

FIG. 8. METHOD OF ARRANGING HAULING LINES.

A number of these 'chokers' are placed around the stumps in such a manner as to act as slip nooses. The 'chokers' are then hooked to the main line, and, when strain is brought on from the engine, one stump after the other is pulled, without change of crew or stopping the engine. Where extraordinary strength is necessary, pull of engine can be increased by running the 'choker' through an extra block. Stumps of over 4 ft. diameter, with roots of more than 9 ft., have been readily pulled from the ground and brought to the burning pile for final disposition.

The main line used for pulling purposes is either

FIG. 4. ROOT OF STUMPS GIVING WAY.

1¼, 1½, or 1⅜-in. diameter, while the haul-back line should be of ⅝-in. diameter.

In order to give an idea of the work done by these

FIG. 5. STUMP REMOVED.

engines, an extract of a report is attached. From the report it will be noted how rapidly a thickly stumped acreage can be cleared.

FIG. 3. FOUR-FOOT STUMP JUST AS IT IS BEING PULLED FROM GROUND.

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Date.	Engines.	Stumped, Acres.	Yarded, Acres.	Cleared, Acres.	Total.
1912.					
April	2	....	....	60	60
May	2	88	44	915	1,047
June	3	33	205	889	1,127
July	3	10	10	200	220
August	3	57	47	188	285
September	4	....	....	205	205
October	4	120	155	140	415
November	5	200	....	80	280
1913.					
January	5	220	185	....	405
February	5	333	353	....	686
March	5	622	95	500	1,217
April	5	808	403	430	1,641
May	5	840	347	274	1,461
June	5	159	202	220	581
Totals		3,490	2,046	4,101	9,630

FIG. 7. METHOD OF PILING STUMPS FOR BURNING.

Figure 3 shows a 4-ft. stump at the moment it is being pulled to the ground, and Fig. 4 shows this stump as the roots are giving way; Fig. 5 shows the stump removed, and Fig. 6 serves to demonstrate the size of the root on the stump. Fig. 7 shows the method used for hillocking the stumps into small piles for burning, instead of making one great, massive fire stack.

The reader of this article may believe that an equipment of this kind runs into considerable money, which in a sense is true. The first cost of all good equipment is apparently large, yet equipment for the stumping of acreage can be purchased at a cost of less than $5000, the requirements being a special compound geared yarding engine, blocks, wire rope, hooks, etc., and the employment of three or four experienced woodsmen who have handled large timber in the forest.

This method of stumping is vastly superior to dyamiting, which has a tendency to cast over great acreages pieces of stumps which have been blown and thrown through the air.

FIG. 6. SIZE OF ROOTS ON STUMP PULLED.

About thirty miles of concrete roads will probably be built in Milwaukee county, Wisconsin, this year, slightly exceeding the mileage built last year. "We feel well enough satisfied with the type to continue building them," wrote H. J. Kuelling, County Highway Commissioner, in a letter to the National Automobile Chamber of Commerce, "and feel that they are more economical than any other type we could build under present conditions." In deciding upon the adoption of concrete pavement, the county commissioners took into consideration the present heavy mixed traffic and the future great volume of motor traffic that must be borne by rural roads leading into large cities. It was recognized that the concrete road, whether more or less durable and satisfactory than brick, granite or asphalt block, or bituminous, concrete would always be available as a base for some other surfacing material. Twenty-two miles of these roads were built in 1913. All work was of the one-course type, 6 in. thick at the edges and crowned to 8 in. at the centre. Contraction joints were spaced 25 ft. apart at first and later increased to 35 ft. This year they will be 50 ft. apart, owing to the freedom from cracking of the pavements already laid, which is attributed to the thorough breaking the old road surface to give a uniform subgrade for the concrete and the drainage of the subgrade.

Soupy concrete should be used for thin walls, but not so wet that the mortar is watery. The concrete should be puddled rather than rammed, the object being to prevent stones from collecting in any one place and causing noticeable voids on the surface.

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The Kern County Oil Protective Association

By E. B. LATHAM*

This association was formed to prevent the flooding of the oil sands in the great Sunset-Midway oilfield through carelessness or ignorance in drilling operations. It is purely coöperative and is sustained by voluntary contributions. Its membership includes practically all the companies operating in this field, from the great corporations owning thousands of acres and making hundreds of thousands of barrels production to the small twenty-acre leases with a production of a few hundred barrels per month.

It may be said, as a general rule, that oilfields die a premature death by drowning. In winning petroleum, the drill generally passes through water bearing sands before it pierces the oil, and often encounters water sands between and below oil sands. Unless precautions are taken to exclude this water which is enormously greater in volume and is heavier than the oil, it would run down the hole, mingle with the oil, and drive it out. The well would pump larger and larger percentages of water until it would be, in effect, a water well instead of an oil well and would not only become of no value, but a menace to all contiguous land.

Water once admitted to the oil bearing sands spreads laterally rapidly, especially in sands from which great amounts of oil and gas have been taken, and travels often to surprising distances as dye tests have shown. It will be readily seen, therefore, that every oil man is 'his brother's keeper,' for, if water is allowed to reach the oil sand in even a single well, it will soon spread to adjoining properties and injure an operator who has taken the greatest care in completing his own wells. Whole districts may be flooded from a few wells in which the water has not been successfully excluded from the oil sands.

The successful exclusion of water is as important to the operator as the successful completion of his well into the oil. This exclusion is accomplished by landing a 'string of pipe' in an impervious stratum between the water and oil bearing sands so securely as to exclude the passage of all water from the one to the other. The well is then drilled on into the oil with a pipe of smaller diameter.

Until recent years the water string has been merely forced into a water-tight formation, such as stiff clay or gumbo, as firmly as possible and allowed to remain so fixed. It was found that water in many cases would eventually eat its way by strong pressure around the shoe of the water string and thence to the oil sand. About ten years ago the practice of using cement around the shoe of the water string and behind the pipe to fill completely the space between the water string and the wall of the hole was suggested and quickly grew in favor until now it has become the accepted practice.

It was found that the oil sands of the San Joaquin Valley fields were especially difficult to protect because of the copious water and the lack of suitable formations in which the water string could be properly landed so that the water shut-off would be permanent. Unquestionably enormous losses of potential production have been sustained through water infiltration in the McKittrick, Kern River, and Coalinga fields. Many of the same operators who opened these fields also helped to develop the Sunset-Midway territory, and from their earlier experiences they fully appreciated that adequate measures should be taken to prevent this water peril in the newer fields.

The California legislature passed an act creating the office of County Water Commissioner. The commissioner was given authority to supervise the plugging of wells to be abandoned and to compel the abandonment of wells that were found to be a nuisance on account of the excess of water, but he was not provided with means to abate the water nuisance should the owner refuse to follow his instructions. Moreover, he was not given the authority or means to aid in shutting off water from the oil sands in the progress of well drilling.

About five years ago, when the water problem first became serious in the Midway field, a number of operators formed a small association and subscribed money to amplify the salary of the water commissioner and furnish the necessary funds for his expenses. He was required to assist all the operators as much as possible with advice and to keep in touch with field operations. At this time cementing was a comparatively new method and many superintendents unfamiliar with the necessary requirements failed to get satisfactory results. The commissioner was of great assistance during this period. Eventually nearly all of the companies employed cement contractors who made a specialty of cementing wells, and much better results followed. The proportion of failures changed from two out of five to one out of ten, and today, except in the very large companies, the cementing is in the hands of these contractors, who furnish all necessary equipment and are entirely competent.

Gradually it was realized that it would be impossible to prevent the infiltration of water into the oil sands of any given district unless the driller know the expected position of the various water and oil sands beneath the surface at any given place. Without geological assistance it would be almost impossible for the driller to gain these facts, since there are local obscure folds in the rocks in addition to the broader structural features. The larger companies have always

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maintained resident geologists in the field to advise their drillers in regard to positions of water and oil sands, but the owners of small properties usually did not have such assistance.

The need of more general coöperation and concerted action on the part of the larger companies and the desire to help the small operator in the successful shutting out of water from the oil sands led to the organization of the Kern County Oil Protective Association about two and a half years ago. Practically all of the operators joined; they taxed themselves proportionately on their acreage and production. A head office was located at Bakersfield and a field office was established at Taft, in the heart of the Midway district; the commissioner continued his work in coöperation with the Association, and a deputy and geologist were employed. All the companies furnished their well logs and records and drilling information to the field office, which became a clearing house in which such data were digested, organized, and correlated; geological information and advice was furnished without charge to any *bona fide* operator. An executive committee of the Association, serving without pay, meets in Bakersfield monthly to receive and discuss reports from the field force, to meet individuals or groups of operators for purposes of coöperation in combating growing or troublesome water problems, and to conduct the general business of the organization. This work has continued and without question has been of great service and benefit to the field.

With the coöperation of the operators, a great mass of data are secured, from which the underground structure of the field, as far as the oil sands and water formations were involved, are worked out; peg models of the important areas of the field and numerous cross-sections are constructed so that underground conditions are made so plain that any superintendent or one interested can readily understand the structure and kind of rock beneath the surface of his land.

The aim of the organizers of the Association was to fight the water evil in a scientific and uniform manner; to do what they could to remedy old mistakes; but chiefly **to prevent future mistakes being made.** It may be said at once that by the coöperation of all concerned and the geological work done, the field is so thoroughly understood today that there is no excuse for shutting off water in the wrong place. This is the chief consideration, for had the lack of knowledge of the relations of the water and oil strata which existed three years ago continued, there would be no possibility today of correcting the water infiltration which undoubtedly would have ensued.

Today there is no question but that every interested man fully appreciates the importance of shutting off water. No half-way or slovenly measures are tolerated by the companies themselves, and the cementing is in the hands of competent men. The field force of the Association is able, within 24 hours, to give any operator a very close estimate of the depth at which he will encounter the oil sands and water strata and indicate where he should shut off water so that an intelligent casing campaign can be worked out with certainty before the well is started. During one month, 112 operators and superintendents called at the Taft office of the Association for information and assistance. The fact that the operators have continued the Association for this length of time is proof of the necessity for coöperation for protection against infiltration of water into the oil sands.

Since the Association was organized, lower oil sands have been discovered in certain parts of the Sunset-Midway field. These have been often more prolific than higher sands previously known, and in places have produced gushers. Water strata were found between the oil sands. To protect the oil from the upper and intermediate water strata requires the landing of three strings of casing; one above the upper oil sand, a second above and a third below the intermediate water. Recently a third oil zone has been discovered. Should a still lower water stratum be encountered, the difficulties in preventing the water from escaping into the oil will be greatly augmented.

Several problems of general interest have been solved. Recently the Association completed an elaborate series of tests, covering a period of ten months, in the northern part of the field. It was found that water had entered the upper oil measures, although at the time the wells were drilled no water was encountered. When the water first appeared in the oil, it was the unanimous belief of the operators that it came from strata below the oil sands in wells which had been drilled too deep. Had casing been disturbed and attempts been made to shut off presumed bottom water, the whole territory would have been in a condition which would have prevented the relief that was brought about later by dye tests to determine the source of the water. Systematic dye tests were carried out, the source of the infiltrating water located, wells plugged, and water strings relanded before final proof was obtained which would warrant the companies involved incurring the heavy expense of redrilling some 50 wells. This is a concrete instance of the benefit of the coöperation brought about by the Association.

The work of the Association is to furnish the 'ounce of prevention,' to maintain a bureau to which the operator has access **before** he begins work and risks his money.

There is no movement for conservation of natural resources more deserving of immediate attention than the exclusion of water from the oil measures of the California oilfields. The Association, working without any authority to carry out its recommendations, and depending upon educational and amicable influences alone, has been able to check this water peril and will prevent future mistakes. A law to make proper precautions compulsory on all operators was proposed, but failed to receive executive approval.

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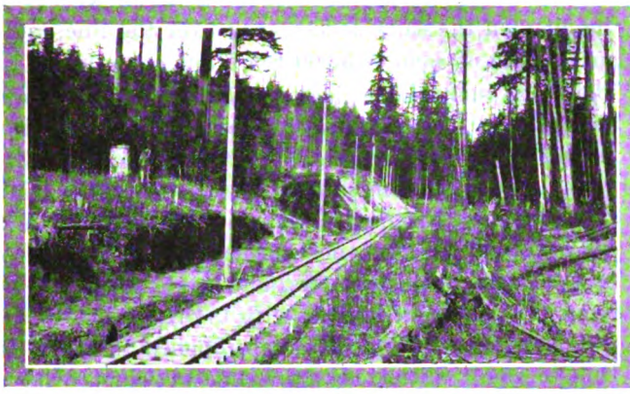


HALES GULCH, LOOKING NORTH.

FINISHED CONSTRUCTION THROUGH SIDE AREA.

Seattle's Municipal Railways

By A. J. QUIGLEY

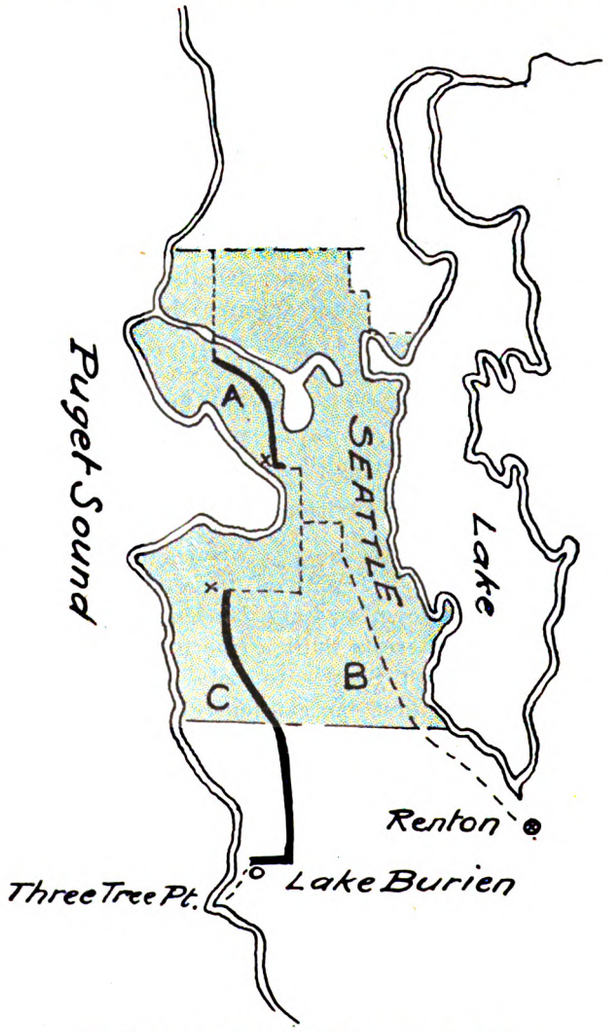
The city of Seattle contains an aggressive voting element whose determination to force the city into street-car ownership and operation has recently borne fruit after a decade of continuous turmoil.

Those who have followed the contest will remember that as early as 1906 a most ambitious scheme of subways and elevated roads, involving an expenditure of over $4,000,000, was placed before the voters and promptly defeated. The second attempt came in March 1911, when there was submitted to the voters the question of a bond issue of $800,000 for the purpose of building and equipping a main arterial way from the south city limits to Ballard on the north. This latter vote was almost two to one (of the limited total cast) in favor of going ahead on the project, and after the usual delays incident to arranging money details, work was finally started in September 1912 by the Jahn Construction Co. of Seattle.

To get a clearer understanding of the situation, reference should now be made to the general map herewith, in which it will be noted that existing roads are shown in solid line, and those proposed in dashes. The development is proceeding in three separate and distinct paths, known respectively as Divisions A, B, and C. The questions and problems involved are different and unique in each case. Hence the somewhat detailed treatment given as follows:

Division A

This lies northward of the city and has previously been referred to as having started in September 1912. The work was carried along without special incident and was finished in October 1913, but, due to power and car difficulties, it was not until May 1914, or seven months later, that actual operations began. The line starts at the northern fringe of the business section and extends in a general northerly direction to the edge of the lumber manufacturing section, a distance of 4.7 miles, of which 4 miles is double and 0.7 mile is single track. In the paved sections, 116-lb. girder rails are used and light T rails in the unpaved sections. The overhead is peculiar in that it is copper return, this system being adopted as one card in the play of the city against the electric railway corporations in



MAP SHOWING EXISTING AND PROPOSED LINES.

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the fight on electrolysis. Twelve cars of the 'P-A-Y-E' type were furnished by the Cincinnati Car Co. These are modern in every respect, contain 24 seats, and will hold a total of 75 passengers. The car-house is near the northern end of the line and is of ordinary type of construction. The cost of construction was officially reported as follows:

Main line (8.7 miles of track)	$169,858
Car-house tracks	7,798
Steam road connection	319
Pole line	9,522
Trolley and feeder system	51,022
Sub-station, including grounds, building, and apparatus	43,943
Cars	76,138
Estimate for line car	4,000
Estimate for additional engineering	2,500
Division B	1,942
Total	$367,042

The superintendent of public utilities is charged with the responsibility of operation. Two cars during the day take care of the traffic available, and others are added night and morning as needed. The round trip is made in 48 minutes. Ordinances covering various details provide for 5c. fares, six tickets for 25c., and half fare for school-children at certain hours. Estimates made in advance claimed that approximately 8000 people would be served by this line; that gross earnings would be $75,000, and that the total expense would be $68,000. Their schedule of expense, however, fails to provide for superintendence, clerk hire, fire insurance, depreciation, tax allowance, and a great many taxpayers view with alarm what they consider an expensive and unnecessary plaything. During a considerable period at least this division is bound to be a heavy loser, and the taxpayers will have the privilege of making good any deficits. By irony of fate the largest contributor through this channel will be the competing railway, the Stone & Webster interests. As yet the line has not been operated long enough to give any real gauge of final results, but certainly they will be awaited with unusual interest by friend and opponent alike.

Division C

The sequence of development brings this section in ahead of Division B. South of the city lies a small body of water known as Lake Burien. In 1911 and 1912, property interests built a line 9 miles long, extending from West Seattle to Lake Burien, and on July 1, 1912, the first car cautiously wended its way back and forth. It was the writer's privilege to travel outward on one of these first days. The little car groaned and creaked along, and the motors bravely hung on to the fast disappearing voltage until within a half mile of the end of the line. There the car stopped and refused to proceed farther until the remaining passengers got out and walked. For four months its sponsors maintained an intermittent service, but then a huge earth slide covered a mile of track and operation was abandoned entirely.

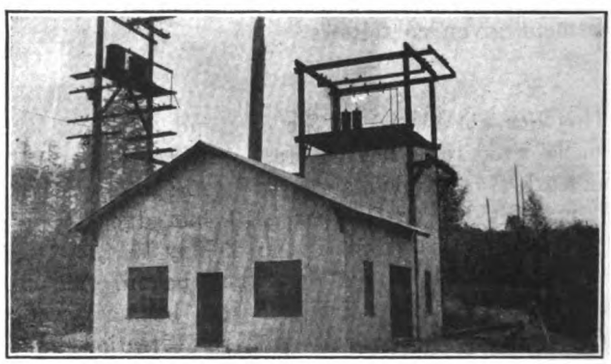
After being refused as a gift by Stone & Webster, the city, on the same terms, took over the line, and at an expense of some $25,000 rebuilt the 9 miles of line. The work included replacing a large amount of overhead and bond copper that had been stolen, gravel ballasting the whole length, digging out and straightening the line, building new sub-station, and providing a 500-kw. motor-generator set with connections in and out. For this work some 50 men, an electric locomotive, a string of dump-cars, and a steam-shovel were required for several weeks, with the result that a short time ago this section was again opened to the public. Due to small initial cost, this line appears to have a much better chance to pay its way than does A. Furthermore, it is serving a section that otherwise would be without service, and in this respect finds some justification.

Division B

This is that portion southward from the business centre through the section known as Rainier valley. This field for years has been occupied by the privately owned Seattle, Renton & Southern Railroad Co., and its checkered career (somewhat responsible for the present municipal ownership cry) is a striking example of the vicissitudes of private ownership in the past few years.

The fight ostensibly has revolved around the question of insufficient service and excessive fares. Up to December 1910, Mr. Crawford was president and manager, but at that time, due to failure to meet bond interest, Peabody, Houghteling & Co., principal bondholders, sent E. W. Mills to become active manager. About this time the city, by ordinance, sought to revoke the Company's franchise. Receivers were appointed by the superior court in August 1912, namely, Joseph Parkin and Scott Calhoun. Since then there has been a quick succession of legal tangles, but the original underlying question of the right to cloud the title through revocation of franchise has remained *in statu quo* until July 28 of this year, when it was finally brought before the federal court.

The city desires to acquire this line to the city limits on favorable terms to serve as its section B. Two principal offers have been made by the railway interests and refused by the city; the first, a flat sale at



SUB-STATION, NINTH S. W. AND CLOVERDALE STREETS.

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$1,200,000, and the other to turn the property over *in toto* to the city and to take in return 25% of the gross receipts for a period of 25 years. The decision soon to be rendered by the federal court can only clear the deck for further legal action, so the realization of section B is still a matter of much uncertainty.

Thus it will be seen that Seattle has a municipal system that is as yet no system at all, for its two present units begin nowhere and end nowhere. Eventually it is hoped and expected by its sponsors that common-user rights will be established which will give the lines connection through the down-town section, that rails will be extended outward as shown by dotted lines, as better to serve outlying territory, and that transfer arrangements will be effected so as to give patrons adequate transfer service. Until then Seattle will be burdened with municipal lines that no sane private investor would care to own. If, in line with Wisconsin's practice, all municipally owned public utility enterprises were subjected to the rigid accounting methods and strict supervision of the various Public Service Commissions, it is highly probable that there would be less clamor for public ownership of public utilities.

To summarize, Seattle has at present two widely separated outlying sections in operation; a third section is an uncertain probability; as now constituted, there is no real system, and the lines are unable to give more than partial service; its patronage must be confined under these conditions to small territory of limited producing capacity. The results as shown thus far hardly constitute a cheering exhibit for the taxpayers and advocates of municipal ownership.

Operating results to date have been as follows:

DIVISION A

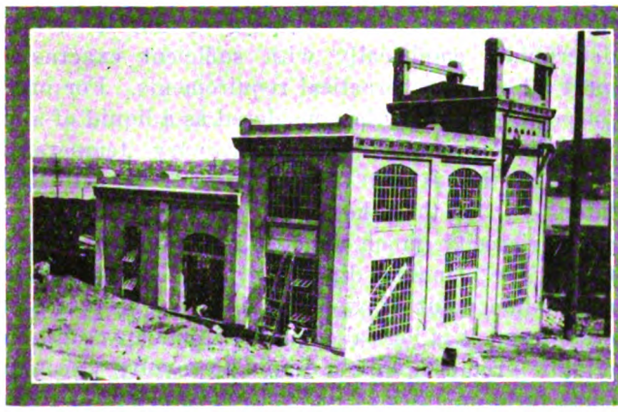
June:	
Receipts	$1346.02
Payroll and expense	1972.18
Power	400.00
Interest	1125.00
Loss	2151.16
July:	
Receipts	$1482.54
Payroll and expense	1861.69
Power	400.00
Interest	1125.00
Loss	1904.15
Totals:	
Receipts	$2828.56
Expense	6883.87
Loss	*4055.31

*Note.—No depreciation, office supervision, accountings, etc., included in above.

DIVISION C

June:	
Receipts	$1635.75
Payroll and expense	1336.98
Power	300.00
Loss	1.23
July:	
Receipts	$2176.40
Payroll and expense	1500.49
Power	300.00
Profit	375.91
Totals:	
Receipts	$3812.15
Expense	3437.47
Loss	†374.68

†Note.—No interest, depreciation, office supervision, etc., included.



SUB-STATION, DEXTER AND ALOHA STREETS.

LATEST TYPE OF P-A-Y-E CAR.

Bags of cement are handled on wooden skips at one of the concrete plants at Section 15 of the Lexington Avenue subway, New York, by the derrick used for delivering buckets of sand and gravel to the concrete-mixing machine. The bucket is permanently attached by a clevis connection to the derrick boom hoisting tackle, and the skip chains are merely hooked to the edges of the bucket, and the bucket, either empty or full, serves as an evening bar for the skips, and enables the latter to be quickly connected and disconnected without the trouble of changing the attachment to the hoisting tackle.

A cement for making repairs on switchboards when iron or other metal has to be fastened to marble may be made from 30 parts plaster of paris, 10 parts iron filings, and ½ part of sal-ammoniac. These are mixed with acetic acid to form a thin paste. This cement must always be used immediately after being mixed, as it solidifies rapidly.

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Notes on the Flow of Oil in Pipes*

By E. I. DYER†

An oil pipe-line is primarily an investment, and as such, exists for the purpose of enabling its owners to derive profit either directly from the operation of the line itself, or from other associated enterprises. The time element has always been an important consideration in its construction. In California, the production of oil has increased at such a rapid rate and with such suddenness at times, that it has been absolutely necessary to build long pipe-lines on short notice, and these conditions have unfavorably influenced their design by putting a premium on practice which, while not usually preventing the pipe-line from being constructed with reasonable certainty of success as an investment, has too frequently not resulted in the most profitable investment possible.

Fortunately, undertakings of this character have been safeguarded, as a rule, by a variety of favorable circumstances tending to offset mistakes of design. One of these has been the absence of competition, due to the costly nature of operations on a scale sufficiently large to render such competition effective, and another has been that experience has developed an empirical practice which provides reasonable protection against a considerable variation in physical conditions. As a rule, builders of pipe-lines have been content to follow closely in the footsteps of others, so that we see on every hand too much slavish imitation and rule-of-thumb engineering, with too little evidence of initiative. As a matter of fact, the immense number of variables to be dealt with, particularly with California oils, is enough to warrant a great deal of conservatism. The necessity for quick action has made designers of pipe-lines the victims of circumstances, and the multifarious duties exacted of most engineers connected with oil companies, together with a general lack of sympathy with research work, has discouraged investigation of the fundamental variables which are at the bottom of all pipe-line design.

Hence it is, that as a rule, the oil pipe-line in California, regarded either as an investment or as a purely physical problem, does not always represent the best possible solution that might be made for exactly the same conditions. The most economical pipe-line for a given service cannot be determined in advance without a working knowledge of the laws governing the flow of oil in pipes in general. The determination of these laws offers the most important single problem in connection with pipe-line work. Everything else depends on it. Unless the loss of head by friction can be predetermined with reasonable accuracy, every element entering into both the first and the operating costs of an installation is uncertain, and should the design be undertaken in an era of keen competition and small margins of profit, a losing venture might easily result.

In view of the importance of this phase of the subject, this discussion is confined as far as possible to points bearing upon the friction head in oil pipe-lines. Neither a full nor a general analysis is attempted, nor is anything offered purporting to be a complete and final solution of the problem. The information offered is of a fragmentary and tentative character, based on observations unfortunately subject to considerable error, as will appear later, and it is hoped that it will promote discussion and stimulate investigations which the importance of the subject demands, and if possible, at the same time, be suggestive of an avenue of approach toward a logical and complete method of determining the friction head for any given oil under any given conditions.

The problem of piping oil differs from that of piping water primarily in the fact that, whereas water is a fluid of well-defined and of almost constant physical characteristics within ordinary temperature limits, oil is quite the opposite; no two oils are exactly alike, and even any one oil is subject to important physical changes under variable temperature. While the flow of water through pipes offers in itself a sufficiently difficult problem, still the laws governing it have been determined empirically with sufficient exactness to meet all ordinary practical requirements. For present purposes water may be considered as a liquid of almost negligible viscosity at all ordinary temperatures, although this is not strictly correct, as will appear later. Oil, on the other hand, is a liquid of relatively great viscosity, much affected by change of temperature. The principal difference between the two from a pipe-line point of view lies in this question of viscosity, and it is logical to suspect that any solution of oil-flow problems will be found to involve viscosity in some form or other.

Viscosity may be defined as that property of a liquid which causes it to offer resistance to relative motion of its parts and to change of form. More specifically, it has been defined by Clerk Maxwell as the tangential force per unit area of either of two horizontal planes at the unit of distance apart, one of which planes is fixed, while the other moves with unit velocity, the space between being filled with the viscous liquid.

The viscosity of any liquid may be measured in the laboratory and can be expressed either as absolute viscosity in c.g.s. or gravitational units, or else in some empirical unit. An arbitrary unit is more convenient for practical purposes, as simple apparatus may be

*Abstract from *Journal* American Society Mechanical Engineers, July 1914.

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used and no computations are required. The instrument used is known as a viscosimeter or viscometer. The type which finds most general application in this country consists of a cylindrical vessel of known volume and form surrounded by a water jacket which may be maintained at any desired temperature. At the bottom of this vessel is a small circular orifice of definite dimensions with a definite form of entrance. A measured quantity of the liquid to be tested is put into the vessel and the time required to run through the outlet in seconds is taken as the viscosity of that liquid at that temperature. Thus, if the time is 30 seconds, the viscosity is called 30. This figure in fact represents the approximate viscosity of water at a temperature of 60°F., and a typical fuel oil of 16 to 17°B. has a viscosity of about 9000 at the same temperature.

It will be seen that the phenomena occurring in this instrument do not differ radically from those in a pipe-line except that the entrance effects are relatively large and the operation is on a small scale, under variable head and under constant temperature. As previously indicated, the viscosity of oil varies over a wide range with change of temperature. Thus, a certain oil of 16.6°B. gravity has a viscosity of 200 at 200°F. and about 13,000 at 50°F. In other words, at the lower temperature it takes 65 times as long to flow through the standard orifice as it does at the higher temperature. The curves in Fig. 1 illustrate the change of viscosity for several crude oils with change of temperature. It is worth noting in passing that the heavy and the light oils tend to show about the same viscosity at a temperature of 200°F., and as we have seen that viscosity is the measure of the resistance of an oil to change of form, these curves should convey a lesson to those who are interested in cutting down the steam required for atomizing oil in burners. The same sheet also shows the effect of change of temperature on water; although the change is not great as compared with oil, still it is quite noticeable.

Having noted the effect of temperature variation on the viscosity of oil, it will be instructive to make similar observations on the effect of temperature on the resistance to flow of oil in pipe-lines. In making these observations it has been convenient to use the Chezy formula in the form given by Unwin for use with water. This formula is largely used by engineers and may be expressed as follows:

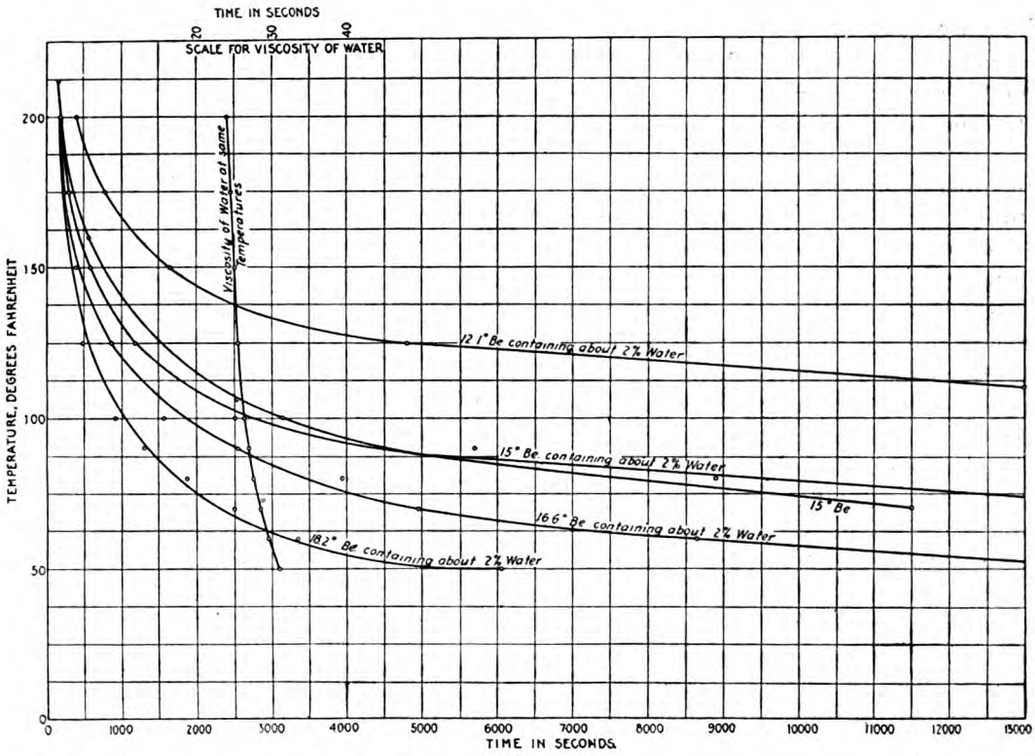

FIG. 1. CURVES SHOWING RELATION OF VISCOSITY TO TEMPERATURE IN SEVERAL DIFFERENT CRUDE OILS.

$$h = 0.1008 \frac{\varsigma Q^2 L}{d^5} \quad \ldots\ldots\ldots\ldots\ldots [1]$$

Where ς = an arbitrary coefficient depending on diameter, velocity and roughness of surface
h = loss of head, feet
Q = quantity, cubic feet per second
L = length, feet
d = diameter, feet.

Transposing, we have

$$\varsigma = \frac{hd^5}{0.1008 Q^2 L} \quad \ldots\ldots\ldots\ldots\ldots [2]$$

By use of this last expression, ς can be determined without difficulty for any oil in a pipe-line by a series of observations, for any temperatures, size of pipes, rate of flow, etc. At the same time the viscosity of the same oils over the same range of temperatures can be

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determined with a viscometer. Two sets of curves can then be plotted, one showing the relation existing between temperature and ς as observed in a pipe-line and the other, the relation between temperature and viscosity as determined by the viscometer. From these curves two empirical equations may be determined and t (temperature) eliminated, giving ς in terms of viscosity. By substituting this value of ς in equation [1] we would then expect to have an expression of the form

$$h = \frac{cQ^2Lf(\eta)}{d^5}$$

where c is a constant and $f(\eta)$ represents some function of η, the coefficient of viscosity. By a series of tests we might reasonably expect to be able to determine by these means such constants as would enable us to predetermine the drop in pressure for any oil in any pipe-line by measurements of viscosity made in the laboratory.

To make the determinations covering all possible conditions naturally requires an extensive equipment, patience, and sustained effort. I have already indicated some of the obstacles in the way of the engineer of the oil company, preventing work of this character being done. Nevertheless it has been possible to keep records of everyday operations which afford some approximation to accuracy. In one place which I have had under observation for some years there are two oil pipe-lines respectively 6 in. and 8 in. diameter and about 2 miles long, which are in intermittent service as occasion demands, carrying a variety of oils, usually at a fairly constant rate of about 500 bbl. per hour. The temperatures available and the rate of flow are such as commercial considerations dictate, so that it has been impossible to make changes for experimental purposes. The mean temperature in the pipe-line averages about 110°F. The lines are buried for practically their entire length, although they are exposed for considerable distances, and for the most part they are practically straight. They are equipped with gauges and thermometers, and the elevations are, of course, known. The gauges are of ordinary commercial type, and therefore at times very unreliable, but they are, however, calibrated at more or less frequent intervals by a standard gauge which is itself checked from time to time on a dead-weight tester. Errors of pressure have undoubtedly crept in; the observations as to quantities, temperatures, etc., are made by the regular operators and are also known to be inaccurate at times. In general, commercial requirements do not permit of the conditions being varied at will for purposes of test, and in other respects they are not ideal. It is particularly unfortunate that higher rates of flow and ranges of temperature have not been available, but their absence should not interfere with the general truth of the deductions which I am about to make.

Values of ς have been computed for the two lines for some 120 or more runs. Those for the 8-in. line have been analyzed and tabulated, and the results given here are for that line. Values of ς have been plotted against temperature as shown in Fig. 2, the temperature used being the arithmetical mean of the temperatures at both ends of the line. The logarithmic mean would probably give greater accuracy, but there are so many other uncertainties that it is probable that the fall of temperature in the line is not strictly uniform anyway. The oil represented in the t-ς curves varies in gravity from 16 to 17°B. There are a few freak points, but on the whole a fair curve can be drawn which is reasonably representative of the average. While the curve may not be strictly correct, it is evident that it unmistakably shows that ς decreases regularly with increase of temperature.

If we compare the t-ς and t-η curves we will at once be impressed by their similarity, and if we examine the viscosity curve for 16.6°B. oil, particularly that portion which lies between the same temperature limits as the t-ς curve, it will be seen that the similarity is very striking. In fact, plotting the two on the same sheet with the same temperature scale and the ς scale suitably adjusted, the curves can be made practically to coincide. By means of this expedient I have deduced the relation

$$\varsigma = \frac{\eta - 930}{30667}$$

Now if this value of ς be substituted in equation [1] we have

$$h = \frac{Q^2L\ (0.001075\ \eta - 1)}{327d^5} \quad \ldots\ldots [3]$$

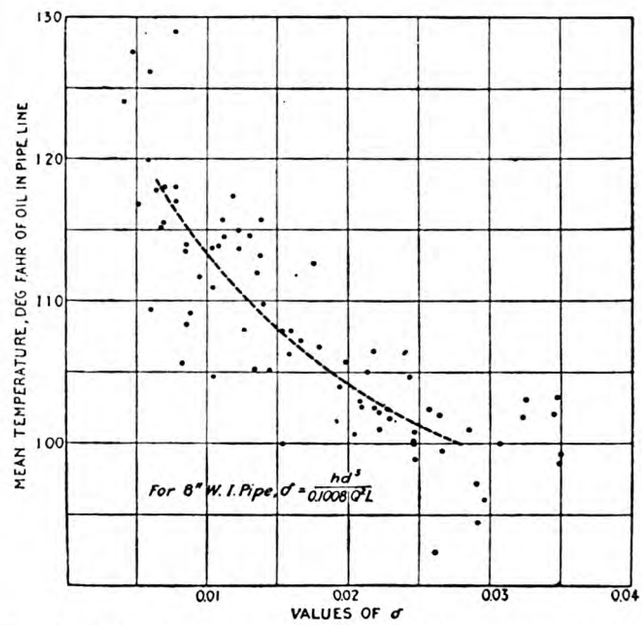

FIG. 2. CURVE SHOWING APPROXIMATE RELATION BETWEEN VALUE OF ZETA AND TEMPERATURE IN 8-IN. PIPE-LINE.

This relation has been checked in several instances and the agreement with observed facts was as close as might be expected under the conditions. You will notice that with viscosity of 930 the expression becomes zero and indicates one of the limits of the formula. The formula is not proposed for serious use, but is given as a sample

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of one method of approach. With an accurate series of observations there is no reason that I see why a formula cannot be developed in this way to cover all conditions.

Therefore if we inspect the temperature—viscosity curves again, it will be seen that what is true of 16.6°B. oil between the temperatures of 100 and 120° appears also to be approximately true for

12 gravity oil between 145 and 165°,
15 gravity oil between 110 and 140°,
18 gravity oil between 75 and 100°,

because the curves are of the same form and general slope between those temperature limits.

I have digressed slightly from the course I had mapped out, wherein I had intended to show how ς might be expressed in terms of η by equating the value of t found from the empirical equations of the temperature-viscosity and temperature-ς curves.

H. E. Boner, engineer of tests of the Union Oil company, has developed the empirical equations for both the sets of curves shown. As a result of his investigations he has found that the equation of the t-η curve is

$$\eta = \frac{(584.5)^{5.42}}{(t + 50)} + 65$$

from which

$$t = \frac{584.5}{(\eta - 65)^{0.1843}} - 50$$

He has also derived the empirical equation for the t-ς curve, which is

$$\varsigma = \left(\frac{70}{t+5}\right)^{8.81}$$

from which

$$t = \frac{70}{\varsigma^{0.1135}} - 5$$

By equating the two values for t thus obtained, the value of ς is found to be

$$\varsigma = \left[\frac{1.555}{\frac{13}{(\eta - 65)^{0.1843}} - 1}\right]^{8.81}$$

Substituting this value for ς in equation [1] we have

$$\eta = \frac{0.1008Q^2L}{d^5}\left[\frac{1.555}{\frac{13}{(\eta - 65)^{0.1843}} - 1}\right]^{8.81}$$

This expression gives values for the lost head somewhat higher than the relation first deduced in equation [3], and, as far as it has been checked, with no greater accuracy. It, however, offers greater promise of extension over a wider range of temperatures. It will be noted that it does not become zero until the coefficient of viscosity becomes as small as 65. I might say that the t-η and t-ς empirical equations when plotted give curves agreeing very nearly with the curves plotted from the original points. In considering these equations, it should be borne in mind that they are developed from a limited series of tests made on but a few oils over a narrow temperature and velocity range.

If an attempt is made to apply them to conditions differing materially from those under which the runs were made, it will be found that correct results will not be given. Therefore, I wish to emphasize the point that I have not been attempting to offer a solution of the problem, but rather to indicate a promising method for arriving at the solution. The velocities used in the above determinations are lower than those found in practice in the field, and this is an important point of difference. The same method of development can be employed to determine the effect of velocity, but this has not been done as yet. I feel certain, however, that the methods indicated, if carried out on an extensive scale and under test conditions, can be made to yield reliable results, and if this actually proves to be the case, the starting point in pipe-line design may be in the laboratory, commencing with the viscosimeter.

Fourth American Road Congress

Final arrangements for the Fourth American Road Congress, to meet at Atlanta, Georgia, during the week of November 9 to 14, are nearing completion. All indications point to a record-breaking attendance and exceptionally strong program, while the demand for exhibit space on the part of manufacturers will far exceed the supply available.

Program

The program carries the names of twenty-five official heads of highway departments of the national and state governments, who will present every phase of construction, maintenance, and administration. Federal aid to road improvement will be ably discussed by Senators Hoke Smith and John H. Bankhead, and by Representatives D. W. Shackleford and William P. Borland. Judge Shackleford is chairman of the Committee on Roads for the U. S. House of Representatives, and Representative Borland is noted for his eloquent championship of a national good roads policy. The executive branch of the federal government will be ably represented by a number of prominent officials and it is hoped that President Wilson will attend. If he does not, it is practically assured that a member of his cabinet will address the Congress.

The military arm of the service will have a place on the program, as Brig. Gen. Wm. T. Rossell, former Chief of Corps of Engineers, U. S. A., and Maj. Amos A. Fries, Corps of Engineers, will take part in the proceedings. Logan Waller Page, Director of the U. S. Office of Public Roads, and president of the American Highway Association; John A. McIlhenny, pres-

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ident of the U. S. Civil Service Commission, will be prominent figures at the sessions of the Congress. The American Bar Association will officially take part in the session of the Congress devoted to road legislation, and will be represented by a special committee, of which Frederick D. Wadhams is chairman. The American Bankers' Association will have a committee to coöperate in the holding of a finance session, at which William G. Edens will preside. It is expected that Hon. John L. Hamilton, former president of the American Bankers' Association, will be one of the speakers. The National Civil Service Reform League will hold a session devoted to a discussion of 'The Merit System in Road Administration,' and at this session Richard Henry Dana, president of the League, will preside.

It is expected that John H. Fahey, president of the Chamber of Commerce of the United States, will be one of the speakers at this session. Fairfax Harrison, president of the Southern railway, will be one of the speakers of the Congress, and will emphasize the importance of the relationship between the railroad and the public road. Highway engineering in schools and colleges will be given attention through addresses by Hector J. Hughes, professor of engineering, Harvard University; Prof. C. M. Strahan, dean of engineering, University of Georgia; Prof. R. D. Kneale, from the department of engineering of the Georgia School of Technology; Prof. E. J. McCaustland, from the University of Missouri, and other prominent educators.

'Road Building Yesterday, Today, and Tomorrow,' will form the subject of an address by James H. MacDonald, former highway commissioner of Connecticut, and one of the pioneers of modern road building. W. E. McClintock, former chairman of the Massachusetts Highway Commission, another of the pioneer road-builders, who has seen this important work develop into a nation-wide activity, will attend the Congress.

The Construction and Maintenance program as now made up is as follows:

DRAINAGE STRUCTURES

By W. F. Atkinson, State Highway Engineer of Louisiana.

Discussion opened by S. D. Foster, Chief Engineer, State Highway Department of Pennsylvania.

SYSTEM IN ROAD MANAGEMENT

By C. J. Bennett, Highway Commissioner of Connecticut.

Discussion opened by Paul D. Sargent, State Highway Engineer of Maine.

MAINTENANCE METHODS AND RELATION TO TRAFFIC

By George W. Cooley, State Engineer of Minnesota.

Discussion opened by H. R. Carter, State Highway Engineer of Arkansas.

CONVICT LABOR

By George P. Coleman, State Highway Commissioner of Virginia.

Discussion opened by J. E. Maloney, State Engineer of Colorado.

RIGHTS-OF-WAY

By Austin B. Fletcher, Highway Engineer of California.

Discussion opened by W. S. Gearhart, State Engineer of Kansas.

SURFACES FOR LIGHT VOLUME MIXED TRAFFIC

By S. Percy Hooker, State Superintendent of Highways of New Hampshire.

Discussion opened by Frank F. Rogers, State Highway Commissioner of Michigan.

EFFICIENCY IN HIGHWAY ORGANIZATION, CENTRALIZATION OF PURCHASES

By E. A. Stevens, State Highway Commissioner of New Jersey.

Discussion opened by John S. Gillespie, Road Commissioner of Allegheny county, Pennsylvania.

STATE CONTROL OF ROAD WORK AS A POLICY

By A. N. Johnson, former State Highway Engineer of Illinois.

Discussion opened by J. H. MacDonald, State Highway Engineer of Iowa.

ENGINEERING SUPERVISION OF ROAD CONSTRUCTION

By W. S. Keller, State Highway Engineer of Alabama.

Discussion opened by R. C. Terrell, State Highway Commissioner of Kentucky.

ECONOMICS

By J. E. Pennybacker, Chief, Division of Economics, U. S. Office of Public Roads.

EDUCATIONAL FIELD FOR HIGHWAY DEPARTMENTS

By Dr. Jos. Hyde Pratt, State Geologist of North Carolina.

Discussion opened by Col. Sidney Suggs, State Highway Commissioner of Oklahoma.

HEAVY TRAFFIC ROADS

By Henry G. Shirley, Chief Engineer, State Roads Commission of Maryland.

Discussion opened by W. A. Hansell, Superintendent of Public Roads, Fulton county, Georgia.

GRADES AND EXCAVATION

By A. D. Williams, Chief Road Engineer of West Virginia.

Discussion opened by Wm. H. Roy, State Highway Commissioner of Washington.

PROBLEMS OF STREET CONSTRUCTION AND MAINTENANCE

By Charles E. Bolling, City Engineer, Richmond, Virginia.

Discussion opened by F. L. Ford, City Engineer, New Haven, Connecticut.

ROAD BINDERS AND PALLIATIVES

By Chief Engineer Rhode Island State Roads Commission.

Discussion opened by Chas. W. Campbell, City Engineer, St. Joseph, Missouri.

POSSIBLE LINES OF IMPROVEMENT IN CONTRACT HIGHWAY WORK

By John J. Ryan, Secretary, New York State Road Builders' Association.

Discussion opened by L. D. Smoot, City Engineer, Jacksonville, Florida.

Exposition

The elaborate exhibit of the U. S. Office of Public Roads, which is being prepared for the Panama-Pacific Exposition, will be shown intact at the Road Congress and will include not only exact models of every known type of road, and the historical development of road-building from the earliest times, but will also comprise special models showing road location, the beautifying of the roadside, and mountain road construction as exemplified in the splendid Swiss roads. The New York State exhibit will include at least one example of model work, which it is claimed will prove one of the most impressive exhibits at the Congress. A number of other states will have interesting exhibits in

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the form of models, maps, and materials. The exhibits will be placed in the auditorium, a huge structure belonging to the city of Atlanta and designed specially for meetings and exhibit purposes. Taft hall, in which the sessions of the Congress will be held, is in the auditorium, so that the visitors and delegates may inspect the exhibits and attend the meetings without the inconvenience of going from one building to the other. All available space in the auditorium for commercial exhibits has been taken, as well as the entire area of Gilmer street for a distance of one city block. A temporary structure with wooden roofing and canvas sides will be erected to protect all of the exhibits on Gilmer street, and will be so arranged as to make it a continuous structure with the auditorium. A viaduct extending from Gilmer street a distance of two blocks, has been obtained for the exhibit of heavy machinery in operation, and already 70% of this space has also been taken. All indications point to an exposition of road machinery, material, and engineering instruments which will surpass all records in magnitude. All possible arrangements are being made for the comfort and convenience of the exhibitors, such as special telegraph and telephone offices, stenographic and typewriting facilities, efficient janitor service, and police and fire protection. A special feature of interest to exhibitors will be a moving-picture room, which the management of the Congress provides without cost, including moving-picture machine and operator for the use of exhibitors.

UNIT BIDS, SAN FRANCISCO TWIN PEAKS TUNNEL PROJECT

Through the courtesy of the San Francisco City Engineer's office, we are able to present the unit bids of Hans Pedersen, of Seattle, for the construction of the Twin Peaks tunnel. These data supplement the article published in the October issue descriptive of the project. The contract time for completion of the work is 1000 days.

2940 lineal ft. of standard tunnel section for earth or soft material, of reinforced concrete, with an arch of concrete or brick, and including complete drainage system, all ducts and conduits for electric cables, and the fill to subgrade over the invert, are to be constructed—per foot	$ 330
4020 lineal ft. of standard tunnel section for soft rock, of reinforced concrete, with an arch of concrete or brick, and including complete drainage system, all ducts and conduits for electric cables, are to be constructed—per foot	240
2500 lineal ft. of standard tunnel section for hard rock, entirely of reinforced concrete and including complete drainage system and all ducts and conduits for electric cables, are to be constructed—per foot	240
30 lineal ft. of 29-ft. 6-in. tunnel section of reinforced concrete, with an arch of concrete or brick and including complete drainage system and all ducts and conduits for electric cables, are to be constructed—per foot	350
1360 lineal ft. of standard flat top section of reinforced concrete, including complete drainage system and all ducts and conduits for electric cables, are to be constructed; this item also includes the replacing of sewers, curbs, sidewalks, and pavements that may have been disturbed in the construction of this section—per foot	260
1 taper connection of reinforced concrete, with an arch of concrete or brick, and including complete drainage system and all ducts and conduits for electric cables, is to be constructed at Clover street, for the sum of	63,350
1 easterly approach, including retaining walls for the approach, the portal, adjacent curbs, and all work necessary to connect with the standard flat top section, and complete drainage system, is to be constructed, for the sum of	21,000
1 retaining wall, including stairs, adjacent curbs and sidewalk and tile drain, is to be constructed on the south side of Seventeenth street according to its new alignment; this item will also include the regrading, the resetting of curbs, the removal and reconstruction of sewers and appurtenances, the removal and reconstruction of pipes and appurtenances for the auxiliary water supply system, the reconstruction of sidewalks and pavements in Seventeenth street from Collingwood street to Castro street, in Castro street from States street to a point 52 ft. more or less south of Seventeenth street, and in Market street, for the sum of	37,450
1 station, including stairs, kiosks, surface cement sidewalks, leading to nearest streets, complete drainage system and all ducts and conduits for electric cables, is to be constructed in Eureka valley; this item also includes the replacing of sewers, curbs, sidewalks, and pavements that may have been disturbed in the construction of the station, for the sum of	132,000
1 ventilating intake station is to be constructed in Eighteenth street east of Clover street; this item; includes the dust manhole and the ducts leading to the tunnel section, a 6-in. drain to manhole, and all work over and outside the neat tunnel sections to complete the proposed ventilating station, for the sum of	7,200
1 ventilating intake station is to be constructed in the Relief Home tract; this item includes a section of tunnel of special heavier construction and 17 ft. in length, the ventilating shaft and housing complete, for the sum of	20,000
1 station referred to in the plans as Laguna Honda station is to be constructed; this item will include the station building on the ground surface with adjacent curbs and sidewalks, the underground station with stairs and elevator shafts and all work necessary to connect the herein proposed work with the standard tunnel sections, for the sum of	280,000
1 westerly portal is to be constructed at the westerly end of the tunnel; this item will include the adjacent curbs and sidewalks, the dust manholes and the ducts outside of the tunnel proper and all necessary work to connect to the standard tunnel section, for the sum of	7,500
1 drain for tunnel, including manholes, is to be constructed in Eighteenth street from the end of the 29-ft. 6-in. section to Douglass street, for the sum of	4,800
1 drain for tunnel, including manholes, is to be constructed in Collingwood street from the standard flat top section to Eighteenth street, for the sum of	2,900
Total	$3,475,300

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Cost and Method of Constructing a Section of Cascade Scenic Highway

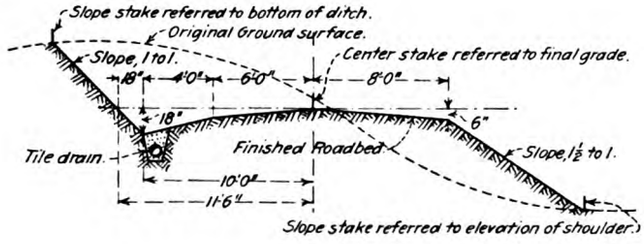
In the issue of February, 1913, an article was contributed by A. P. Denton, county engineer for Kings county, Washington, describing the Cascade Scenic Highway project. A short time ago the county officials placed a contract with Bruce, Nettleton & Eischbaugh, contractors of Seattle, for constructing a section of standard 12-ft. roadbed from the Snohomish-King county line near Baring to the summit of the Cascades, King-Chelan county, approximately 28 miles in length, the total contract aggregating $141,170.10. The unit bid prices quoted by the contractors were based upon the following approximate quantities:

TOTAL APPROXIMATE ESTIMATE

	Div. No. 1. Sta. 0+00 to Sta. 22+00.	Div. No. 2 & 3. Sta. 222+00 to Sta. 950+00.	Div. No. 4. Sta. 9+50 to Sta. 1443+00.	Total.
Length of improvement, lineal feet	22,200	72,800	49,320	144,320
Clearing, acres	15.66	100.46	66.79	182.91
Grubbing, acres	0.104	15.646	12.317	28.067
Excavation, common—Roadbed, cubic yards	20,451	116,642	63,822	200,915
" " —Sills	.....	.....	.....	.....
" " —Culverts and diversions, cubic yards	640	1,952	817	3,409
Excavation, loose rock—Roadbed, cubic yards	2,783	9,252	1,110	13,145
" " " —Sills	.....	.....	.....	.....
" " " —Culverts and diversions, cubic yards	.....	.....	.....	.....
Excavation, solid rock—Roadbed, cubic yards	2,399	12,087	3,024	17,510
" " " —Sills	.....	.....	.....	.....
" " " —Culverts and diversions, cubic yards	.....	25	.....	25
Overhaul (400 ft. free haul), cubic yards per station	28,902	104,915	71,565	205,382
Bridges, lumber in trestles (in place), feet B.M	.....	24,020	38,896	62,916
All other lumber (in place), feet B.M	154,820	73,848	190,530	419,198
Sills, cedar, lineal feet	732	144	120	996
Piling driven, lineal feet	.....	801	1,686	2,487
Hardware, pounds	4,030	13,069	24,415	41,514
Bulkheads and cribs (including hardware) face logs, sq. ft. face	10,262	14,632	5,821	30,715
Tie logs (including hardware), lineal feet	2,496	3,660	1,160	7,316
Removing old bulkheads, sq. ft. face	7,432	.....	.....	7,432
Rock filling for cribs, cubic yards	.....	96	210	306
Cedar log culverts:				
1 by 2 ft., lineal feet	52	1,240	208	1,500
2 by 2 ft., " "	32	886	522	1,440
2 by 3 ft., " "	24	.....	24	324
2 by 4 ft., " "	.....	338	24	362
3 by 3 ft., " "	10	378	292	680
3 by 4 ft., " "	66	170	100	336
4 by 4 ft., " "	46	178	158	382
Wood stave pipe, lineal feet	.....	.....	30	30
Galvanized iron ells, 45°, for wood stave pipe, each	.....	.....	2	2

All cement required was furnished by the county to the successful bidder at $1.28 per barrel, f.o.b. cars Bellingham, or $1.47 per barrel f.o.b. cars Seattle. The above prices do not include the sacks. The contractors' unit bid follows:

	Div. 1.	Div. 2 & 3.	Div. 4.
Clearing, per acre	$30.00	$165.00	$100.00
Grubbing, per acre	60.00	250.00	200.00
Common excavation, including haul of 400 ft.; per cu. yd.	0.29	0.22	0.24
Solid rock excavation, including haul of 400 ft.; per cu. yd.	0.98	0.79	0.79
Loose rock excavation, including haul of 400 ft.; per cu. yd.	0.60	0.60	0.60
Common borrow excavation, including haul of 400 ft.; per cu. yd.	0.29	0.22	0.24
Solid rock excavation, including haul of 400 ft.; per cu. yd.	0.98	0.79	0.79
Loose rock excavation, including haul of 400 ft.; per cu. yd.	0.60	0.60	0.60
Overhaul on any of the above-named materials, per each 100 ft.	0.01¼	0.01¼	0.01¼
Side surfacing, per lin. ft.	0.60	0.60	0.60
Riprap, loose, per cu. yd.	1.25	1.25	1.25
Riprap, hand placed, per cu. yd.	2.50	2.50	2.50
Slope wall, per cu. yd.	3.00	3.00	3.00



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	Div. 1.	Div. 2 & 3.	Div. 4.
Rubble masonry, per cu. yd.	$15.00	$8.00	$8.00
Concrete, first class, per cu. yd.	20.00	16.00	16.00
Concrete, second class, per cu. yd.	17.00	14.00	14.00
Pipe rail, per lin. ft.	....	.....	.....
Cast iron, spikes and bolts in place, hardware, per lb.	0.06	0.06	0.06
Structural steel, per lb.	0.09	0.08	0.08
Reinforcing bars, per lb.	0.07	0.07	0.07
Expanded metal, per sq. ft.	0.10	0.10	0.10
Lumber in place, per M.B.M. (not including spikes and bolts)	30.00	26.25	26.25
Piling driven, per lin. ft.	0.90	0.75	0.68
Piling cut off, per lin. ft.	0.40	0.25	0.20
Cedar log bulkheads, per sq. ft. (face logs including drift bolts)	0.28	0.23	0.23
Cedar tie and anchor logs, per lin. ft. (including drift bolts)	0.25	0.20	0.20
3-in. porous tile, per lin. ft.	0.80	0.75	0.75
6-in. porous tile, per lin. ft.	0.85	0.80	0.80
8-in. porous tile, per lin. ft.	0.93	0.88	1.15
Cedar log culverts—per lin. ft.:			
1 by 1 ft.	1.40	1.15	1.38
1 by 2 ft.	1.68	1.38	1.61
1 by 3 ft.	1.96	1.61	1.84
2 by 2 ft.	2.34	1.84	2.07
2 by 3 ft.	2.52	2.07	2.53
2 by 4 ft.	3.08	2.53	2.53
3 by 3 ft.	3.32	2.72	2.72
3 by 4 ft.	3.64	3.00	3.00
3 by 6 ft.	4.40	3.53	3.54
4 by 4 ft.	4.20	3.45	3.45
4 by 6 ft.	4.85	4.00	4.00
4 by 8 ft.	6.45	5.30	5.30
Corrugated metal pipe—per lin. foot:			
8 in., 18 gauge	1.00	1.00	1.00
12 in., 16 gauge	1.40	1.40	1.40
18 in., 16 gauge	2.00	2.00	2.00
24 in., 16 gauge	3.35	3.35	3.35
30 in., 14 gauge	3.75	3.75	3.75
36 in., 14 gauge	4.50	4.50	4.50
Vitrified tile pipe, second grade —per lin. ft.:			
8 in.	0.65	0.65	0.65
12 in.	1.05	1.05	1.05
18 in.	1.85	1.85	1.85
24 in.	3.00	3.00	3.00
30 in.	7.00	7.00	7.00
36 in.	12.00	12.00	12.00
Cement or concrete pipe—per lin. foot:			
12 in.	1.10	1.10	1.10
18 in.	2.10	2.10	2.10
24 in.	3.05	3.05	3.05
30 in.	4.35	4.35	4.35
36 in.	6.75	6.75	6.75
Water barrels, each	4.00	3.50	3.50
Puncheon, per lin. ft.	0.20	0.15	0.15
Embanking railing—per lin. ft.:			
Design No. 1	0.25	0.19	0.19
Design No. 2	0.25	0.16	0.16
Design No. 3	0.23	0.14	0.14
Rock for filling crib, per cu. yd.	1.93	1.38	1.38
Truss lumber in place, per M. B.M.	50.00	43.00	43.00
Fir logs for bridge stringers, per lin. ft.	0.28	0.19	0.19
Fir or cedar half-logs for flooring, per lin. ft.	0.16	0.15	0.15
14 and 20 in. wood stave pipe, per lin. ft.	$2.25	$2.00	$2.00
14 and 20 in. galv. iron ells, 45°, per lin. ft.	30.00	27.50	27.50
Removing old bulkheads	0.10	.....	.....
Cedar sills	0.30	0.25	0.25

The right-of-way will be cleared to a width of 20 ft. on each side of the centre line. Under the head of 'Clearing' is included the removal of all trees, brush, and other vegetable matter. Stumps, roots, logs, and other obstructions are to be grubbed out and removed from all places where embankments occur less than 3 ft. in height and where excavations occur less than 3 ft. in depth. Under the caption of 'Excavation' is included all excavation for the formation of the roadbed, digging of all trenches and open drains, cutting new channels for streams, foundation pits for bridges and culverts, and altering all intersecting highways or private roads.

Excavation is in every case measured by the cubic yard and is classified under the heads of solid rock, loose rock, and common. Borrow is classified likewise. Borrow pits will be connected with ditches and drained to the nearest natural outlet. Side slopes of borrow pits are to be made the same as for the cross-section of the adjoining roadbed. A berm of not less than 6 ft. in width is to be left between the slope sticks of the embankment and the ditch of the borrow pit, while a 2-ft. berm is to be left between the outside slope of the borrow pit and the right-of-way line. For solid rock excavation, the contractor will excavate 8 in. below the grade and back-fill. Where the cut and fill occurs, the road averages 0.7 ft. or less of grading, not including gutters. Any material falling under the classification of common excavation is considered as side surfacing and not as material excavated.

Side surfacing is estimated only on stretches exceeding 400 ft. in length. Riprap is treated under two subdivisions, namely, loose and hand placed. The former consists of selected stone placed on the outside of the embankment; the latter consists of stone as nearly rectangular as possible, 60% of which shall have a volume of not less than one cubic foot and be laid by hand. Riprapping is started at the toes of the embankment by digging a trench and placing a course of the largest stone therein. As far as practicable, the size of the stone will be decreased from the bottom to the top of the riprap. Slope walls, wherever necessary, are to be made of stone not less than 6 in. thick or less than 1 cu. ft. in volume where the bed of the wall is concerned, while similar stone may be used to fill the interstices.

Rubble masonry such as is used for bridge abutments, vertical and battered walls, and culverts, consists of portland cement mortar composed of one part cement and two parts of sand. Sand and cement are to be dry mixed before adding water. Stone for masonry will consist of not more than one-quarter less than 1 ft. thick, and no stone less than 6 in. thick, or

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having a bed area less than 1 square foot. Bond of all stones in face, heart, and back, shall in no case be less than 6 in., and joints, both vertical and horizontal, are to average not more than 1 inch.

Concrete is divided into first and second class. First-class concrete is in the proportion of one part portland cement, two parts sand, four parts broken stone or gravel. Second-class concrete is to be mixed in the proportion of one part of portland cement, three parts of sand, and five parts of broken stone or gravel.

If hand labor is used for mixing, the following method is prescribed: A tight floor of either planks or sheet iron is to be used for the mixing platform. Dry sand will be first piled up from the floor with the cement in the proper proportions; the mass will then be shoveled as many times as are necessary to make the mixture a uniform color and without streaks. Sufficient water will then be added to make a stiff mortar, and the mass shoveled over twice or more, as may be necessary. The stone or gravel, which should be well wet, will then be added, and the entire mass shoveled over twice or more before shoveling to the carriers. The mixing may be done by a machine which shall be of the best type, in which the proportions for each batch are exactly measured. A continuous mixture is positively forbidden. Cement is considered as weighing 94 lb. per sack and containing 1 cu. ft. The backfilling behind the wing-walls and abutments is not to be made until same has been allowed to set not less than two weeks. Filling is to be made in layers not exceeding 1 ft. thick, and shall be thoroughly rammed. All voids, pockets, or other crevices, exposed upon the removal of the forms, are to be filled with cement mortar mixed in the same proportions as that in the concrete. All piling, whether for the foundations, trestle work, or pile bridges, is to be of cedar not less than 9 or more than 14 in. diameter at the small end, or less than 14 in. diameter at the cut-off end, and in such lengths as may be required. All piles are to be driven to foundation of such firmness that penetration caused by a 3500-lb. hammer falling 15 ft. shall not exceed 2 inches.

The *Mississippi*, an internal-combustion engine liner, just launched at Glasgow, is the first of a number of such ocean-going vessels to be thus constructed in Scotch yards. It will be fitted with two 4-stroke cycle single-acting Diesel engines, each coupled direct to its line of shafting; also two 4-stroke cycle single-acting auxiliary Diesel engines, each coupled direct to its dynamo and air-compressor. Each of the main engines has six cylinders 26⅜ in. (670 millimetres) diameter and 39-in. (1000 millimetres) stroke, with 105 revolutions per minute. The normal horse-power will be 1600 individual horse-power for each engine. The new vessel is 383 ft. 9 in. long over all, and 50 ft. 4 in. extreme beam, having a gross tonnage of about 5000, and is built on the usual approved plan as regards watertight bulkhead construction and double bottom.

Engineers' Note Book

SAFE LOADS FOR ROPES AND CHAINS.

Chain hooks and similar parts should slowly bend if overloaded and thus give warning of their unsafe condition. They should therefore be well annealed, and never tempered or hardened. A brittle part will snap outright and drop the load.

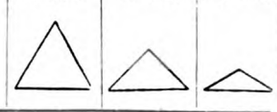
It is clear that hoisting appliances should be suitably designed and well made. It is yet more important that their use be carefully and intelligently supervised and their original strength maintained. There is evidently not so much danger when handling unusually heavy loads, for such operations are, as a rule, under the care of the most capable men, who anticipate the extra risk by careful preparation. Hoisting accidents more frequently occur when ordinary loads are being handled by ordinary men, and when the usual facilities are either too light, wrongly employed, or weakened by wear or use.

It is of first importance that men using hoisting accessories should know the strength of the same. It is not sufficient to know the size, unless the grade is also known. While 1500-lb. may be a safe load for a single sling made of ⅜-in. plow steel wire rope, such a load would be excessive for an iron wire rope sling of the same diameter. This wide range of strength also occurs in different grades of chains and other accessories, but the difference is not readily apparent. It is therefore dangerous to provide several grades of slings and hooks in

SAFE LOADS FOR ROPES AND CHAINS
(IN POUNDS)
Prepared by National Founders' Association.

CAUTION: When handling molten metal, wire ropes and chains should be 25% stronger than indicated in table.

NOTE. The safe loads in table are for each SINGLE rope or chain. When used double or in other multiples the loads may be increased proportionately.



	DIA	WHEN USED STRAIGHT	WHEN USED AT 60° ANGLE	WHEN USED AT 45° ANGLE	WHEN USED AT 60° ANGLE
PLOW STEEL WIRE ROPE (*6 strands of 19 or 37 wires.*) If crucible steel rope is used reduce loads one-fifth.	⅜"	1,500	1,275	1,050	750
	½	2,400	2,050	1,700	1,200
	⅝	4,000	3,400	2,800	2,000
	¾	6,000	5,100	4,200	3,000
	⅞	8,000	6,800	5,600	4,000
	1	10,000	8,500	7,000	5,000
	1⅛	13,000	11,000	9,000	6,500
	1¼	16,000	13,500	11,000	8,000
	1⅜	19,000	16,000	13,000	9,500
	1½	22,000	19,000	16,000	11,000
	DIA. OF IRON				
CRANE CHAIN (*Best Grade of Wrought Iron, Hand-made, Tested, Short Link Chain*)	¼"	600	500	425	300
	⅜	1,200	1,025	850	600
	½	2,400	2,050	1,700	1,200
	⅝	4,000	3,400	2,800	2,000
	¾	5,500	4,700	3,900	2,750
	⅞	7,500	6,400	5,200	3,700
	1	9,500	8,000	6,600	4,700
	1⅛	12,000	10,200	8,400	6,000
	1¼	15,000	12,750	10,500	7,500
	1⅜	22,000	19,000	16,000	11,000
	DIA. / CIR				
MANILA ROPE (*Best Long Fibre Grade.*)	⅜" / 1"	120	100	85	60
	½ / 1½	250	210	175	125
	⅝ / 2	360	300	250	180
	¾ / 2¼	520	440	360	260
	⅞ / 2¾	620	520	420	300
	1 / 3	750	625	525	375
	1⅛ / 3½	1,000	850	700	500
	1¼ / 3¾	1,200	1,025	850	600
	1½ / 4½	1,600	1,350	1,100	800
	1¾ / 5½	2,100	1,800	1,500	1,050
	2 / 6	2,800	2,400	2,000	1,400
	2½ / 7½	4,000	3,400	2,800	2,000
	3 / 9	6,000	5,100	4,200	3,000

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the same shop. Furthermore, a new workman, fresh from a shop in which only the strongest slings and hooks are employed, is liable to assume that the appliances in the new shop are equally strong. The safety of workmen therefore requires that all slings of equal size should be of equal strength, and of maximum strength, and that other details are proportionately strong.

While workmen who are accustomed to the use of slings acquire, by long experience, a valuable knowledge of the strength of chains and ropes under varying conditions, this should not be left to guesswork. It is advisable to post in conspicuous places in the shop, especially at the chain racks, and, where possible, at the point of operation of each crane, a chart showing the loads which can be safely supported by slings of various sizes, whether used normally or in a manner that decreases their lifting capacity. From a study of satisfactory crane practice in various large plants, a chart of safe loads has been compiled, which is published herewith. The loads recommended in this chart are more conservative than those usually specified, because it is intended to recognize the possible existence of slight, unobserved weaknesses in slings and the liability of excessive strains which may be applied to slings through misjudgment or accident.

It will be noted that the safe loads shown upon this chart are based upon the use of 6 by 19 or 6 by 37 plow steel wire rope; the best grade of wrought iron, hand made chain; and four-strand long fibre manila rope. Here again the advantage of standardizing the grades of materials used for hoisting purposes is an advantage; otherwise the chart would be misleading.

Hints on Practice

CONCRETE SEPTIC TANKS FOR COUNTRY RESIDENCES

The most efficient disposal of sewage remained a problem until the concrete septic tank was invented. It is a simple, cheap, and effective device, rapidly supplanting the dry-well, with its constant menace of water pollution. In brief, there has come to the dweller in the outlying districts his own sewerage plant in concrete, which answers his purpose even better than large city works, for he has neither the tax nor repairs that always attach to a city sewer system. The principle upon which the concrete septic tank operates is extremely interesting. It consists of a long water-tight cistern, through which sewage passes very slowly and evenly. Situated underground, it is warm and dark, thus affording perfect conditions for the development of the bacteria or germs which clarify and render harmless the sewage. After passing through the septic tank, the sewage is practically free from all suspended matter and has the appearance of water. From the septic tank this clear effluent is discharged into three lines of ordinary drain tile.

Size and Location of Tank

While the odor from a septic tank is scarcely noticeable, it is nevertheless best to place it at some distance from the house. Choose a spot easy to excavate so that the top of the tank can be sunk 6 in. below ground-level and where the lines of drain tile will have sufficient fall to carry off the discharged fluid. The tank should be large enough to hold the entire sewage for one day. For a family of eight to ten people occupying a house having two bathrooms fitted with the customary appliances in the way of tubs and stationary wash-stands and downstairs the kitchen sink, a concrete tank having two compartments, each 4 ft. long by 4 ft. wide by 4 ft. high, will be required. Since the top and bottom are each 4 in. thick and the top of the tank is 6 in. below ground level, dig the pit 5 ft. 2 in. in depth. The walls of the tank are 8 in. thick and the partition between the two compartments 6 in. Therefore, the length of the pit should be 9 ft. 10 in. and the width 5 ft. 4 inches.

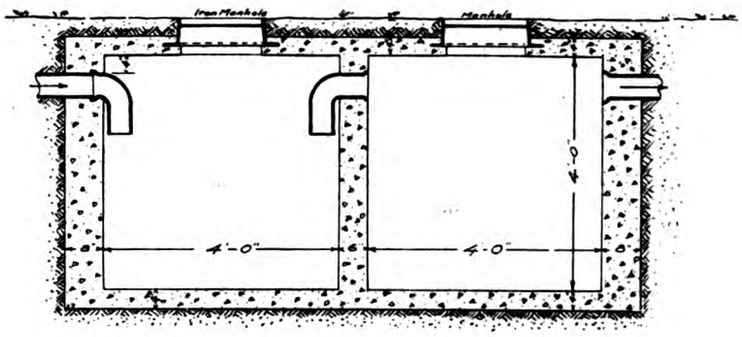

Fig. 1. Cross-section indicating location of pipes.

Making Forms and Placing Concrete

If the earthen walls of the pit stand firm, only inside forms will be needed. These inside forms are merely boxes made of 1-in. boards. Two boxes will be required to make two compartments. The outside dimensions of the boxes should be 4 ft. square by 4 ft. high. The boxes or forms will be placed on the freshly laid concrete floor. Holes for taking 6-in. pipe should be made in the boxes as shown in Fig. 1. The holes should be 4 in. from the top of the box form, measuring from the top of the hole. The concrete should be mixed in the proportion of 1 part portland cement, 2 parts sand, and 4 parts crushed rock or gravel. Place a 4-in. thickness of concrete in the bottom of the pit to form the floor of the tank. On top of this concrete set the box forms, which should be ready for immediate use. Place the forms so that there is a space of 6 in. between them and an 8-in. space between them and the earthen walls of the pit. Then commence depositing the concrete for the walls and partition. As soon as the level of the concrete reaches the holes in the forms place in the holes 6-in. pipes as illustrated. Then continue the concreting until even with the top of the forms.

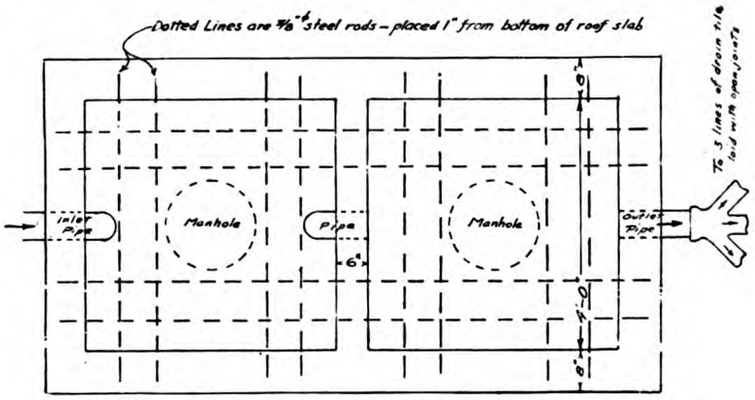

Fig. 2. Plan showing proper position of reinforcing rods.

Reinforced Top and Manholes

Two ordinary iron manhole frames and covers may be obtained from a local dealer in building supplies. The manhole covers should fit tightly and should not be perforated. The manhole frames should be 10 in. high so that when placed on

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top of the forms the upper edge will be even with ground-level. If the manhole frame is of less height than this, it should rest on a circular piece of 1-in. board, which is nailed to the top of the form. Since the concrete roof is to be self-supporting, it will be necessary to reinforce it with a few lengths of ⅜-in. round steel rods. There will be needed four pieces of ⅜-in. rods, 9 ft. 6 in. long, and eight pieces 5 ft. long. The roof is now ready to be placed. Place the manhole frames in proper position on top of the form, and deposit the concrete to a depth of 1 in. and on the concrete lay the long and short bars as shown in Fig. 2. When the bars are placed, deposit the balance of the concrete so as to bring the roof to a total thickness of 4 in. As it will be covered with earth it is not necessary to give this top surface a smooth finish, merely level the surface by striking off with a straight piece of board. The tank should now be allowed to rest undisturbed for at least two weeks. At the expiration of this time, saw away the wooden top of the forms inside of the manhole frames. Then enter the tank and remove the wooden forms, passing the lumber out the manhole opening. While in the tank make certain that the pipes are all unobstructed and not even partly clogged with dirt or lumber. The inlet pipe is then connected to the pipe from the house and the outlet pipe joined to three lines of 3-in. concrete drain tile. The drain tile will be laid about 12 in. below the surface of the ground and the joints left open, that is to say, no mortar must be used in the joints. This permits the discharged fluids to be absorbed by the surrounding soil. The drain tile lines should be laid in the form of the letter 'Y' and sufficiently extended to cover a large area of ground. Average conditions require that each arm be about 100 ft. long. After this is done, cover the tank with earth to the level of the manhole covers. It is now ready for use.

It is sometimes the custom to plant a few shrubs around the manhole openings, thus effectually hiding all evidences of the tank.

Materials Necessary

A tank of the size specified will require about 4 cu. yd. of crushed rock, 2 cu. yd. of sand, and 7 bbl. of portland cement. There will also be needed 78 ft. of ⅜-in round steel rods, which can be obtained from the local dealer. The tank can be built without skilled labor. It requires but few tools, and construction methods are so simple that one man can easily build it.

PACKING GLANDS

From the amount of steam blowing to waste that one sees when walking around any power plant, it seems that gland packing does not receive the consideration that it merits. The majority of men seem to have the idea that if the stuffing-box is full of packing, that is all that is required.

The first and most essential requirement (if the gland is to be steam-tight for any length of time) is an absolutely true rod; without this one will have continual trouble. The second requirement is a closely fitting neckbush. If the neckbush is anything like a slack fit it will allow the full pressure of the steam to blow directly on to the packing, whereas if the bush is a good fit it keeps the steam back. The writer has proved this for himself on various occasions by putting new and well fitting bushes on to old rods; even when the rods have been slightly scored a very marked improvement has been noticed.

The actual filling of the stuffing-box with packing is where a considerable number of men fail. To make a steam-tight gland the packing must be big enough to fill the box; it is no use putting ⅜-in. packing in place of ½-in. and expecting it to squeeze out ½-in. when the gland is nipped up. By far the better way is to put ⅝-in. packing in if ½-in. is not available. Two rounds of packing of the correct size are of more use than twenty rounds too small. Another thing one often sees is the lengths of packing cut too short for the stuffing-box, to save trouble in getting the packing into the box. This should not be allowed. The packing should be of such a length and thickness that it has to be tapped into the box; should it be under size either way, no amount of tightening the gland nuts will ever keep the gland from blowing.

When tightening the gland the best way of checking it for being even is to try a feeler between the rod and the gland. This will be found a far better way than trying the distance between the cylinder cover and the underside of the gland with calipers, especially with rods that have been working any length of time. If the gland is nipped up until the distance between it and the rod is equal all round (this is checked with the feeler), and the underside checked with calipers, a very considerable difference will be found between one end and the other in the majority of cases, amounting sometimes to as much as ⅛ in. When the packing has been nipped down until it is hard, the box should be emptied and filled with fresh packing. Putting in a round of new packing on top of the old is not worth the time taken, besides which the rod is being cut and scored all the time with the old packing. When packing pump glands they should be left sufficiently slack to allow a drop of water to leak to lubricate the rod. The slight loss of water is more than compensated for by the better condition of the rods.

If these simple principles were more generally observed there would not be the need for a lot of the patent packing at present on the market; also the average power plant would have a much neater appearance and be in much better condition, especially the auxiliary machinery.—*Mechanical World.*

FIELD REPORTS ON CONTRACT WORK

The following is a good form for daily field reports adopted by a ditching contractor:

R. F. WARE

LOS ANGELES CALIFORNIA

DAILY LOG

Contract No. ..... At 19

DUG ..... feet

from station ..... to station ..... on ..... st.

" ..... " ..... " ..... "

" ..... " ..... " ..... "

MACHINE	LABOR
Hours Working	Foremen ..... hours
" Idle- Repairing	Engineer ..... "
" " ..... by orders	Operator ..... "
from	Blacksmith ..... "
Hours idle ..... as noted below	" helper ..... "
..... gals. Gasoline	Teams ..... "
..... gals. Distilate	Laborers ..... "
delivered by	" ..... "
Ticket No.	Timekeeper ..... "
delivered 19	
..... gals. lubricating oil	

WE ARE NEEDING- .....

REMARKS, SUGGESTIONS ETC. .....

Weather ..... in charge

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Industrial Progress

GAS-ELECTRIC MOTOR CAR ON SPOKANE, PORTLAND & SEATTLE RAILWAY

The Spokane, Portland & Seattle railway has contracted with the General Electric Co. for a gas-electric motor car, which will be the first car of its type to be employed on this railway. It is the intention to place the car in operation between Portland and Rainier, Oregon, on the Astoria-Columbia division of the road.

Steam trains are now making two round trips each way per day between these two cities, 45.8 miles apart; leaving Rainier at 7:40 a.m. and arriving at Portland at 9:45 a.m., and leaving Portland at 12:50 p.m. and arriving at Rainier at 2:40 p.m.; leaving Rainier at 3 p.m. and arriving at Portland at 5 p.m., and leaving Portland at 5:35 p.m. and arriving at Rainier at 7:25 p.m.

The total distance for the four single trips per day is 183.2 miles. The gas-electric motor car will be required to haul regularly one 25-ton trailer seating 60 passengers. At times when traffic is heavy it may be necessary to haul two trailers of this capacity on both round trips. The schedules of trains composed of the motor car and two trailers will be increased 10 minutes each run with stops of not more than 30 seconds. The maximum grade on this section of the railway is ½ of 1%, extending over a distance of about 3 miles; but, in general, the road follows the Columbia River grade and is nearly level.

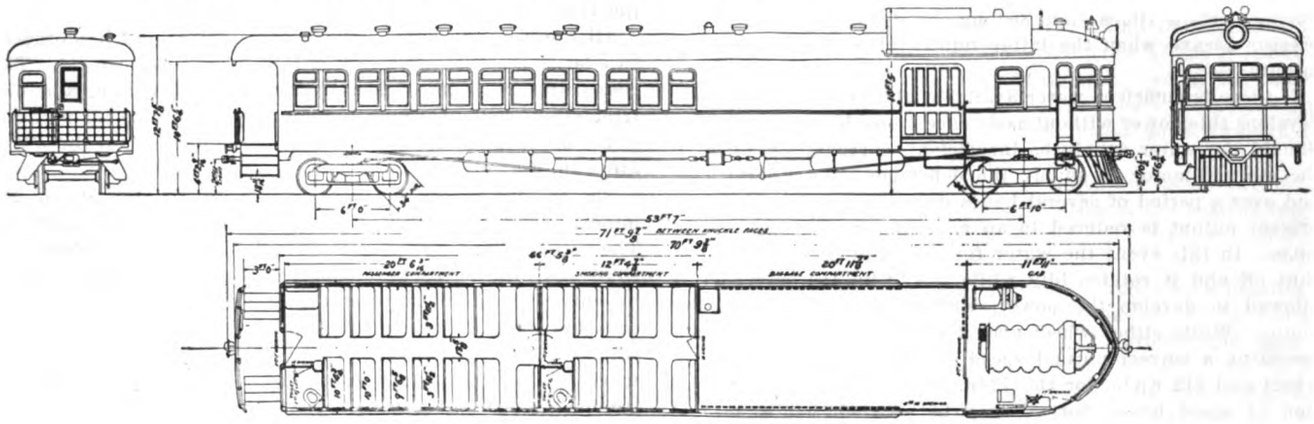
The Spokane, Portland & Seattle railway runs from Spokane, Washington, through Portland, Oregon, to Warrenton, Port Stevens, and Holladay on the coast. It connects with Seattle, Washington, over the Great Northern railway and the Northern Pacific railway. Other connecting lines are the Oregon Trunk railway, Oregon Electric railway, and the United Railways. The road embraces a total of 556 miles, standard 4-ft. 8½-in. track gauge. The rolling stock equipment comprises 69 locomotives, 98 passenger cars and 740 freight and miscellaneous cars.

The gas-electric motor car for this railway is what is known as type RE-70-B-21. The details of construction conform in general to those of the standard cars manufactured by the General Electric Co. It will be noticed, however, that the baggage room in the car is about twice the usual length, in order to transport the large quantity of express handled, particularly the heavy shipments during the fruit season.

The specific dimensions of the car are 70 ft. 11⅜ in. over bumpers by 10 ft. 6⅜ in. wide overall. It weighs approximately 51 tons and has a seating capacity for 68 passengers. The interior is partitioned into four compartments. The cab in front, containing the power-plant apparatus, measures 11 ft. 11 in. long; next is the baggage room, 20 ft. 10⅞ in. long; then the smoking section, 12 ft. 6 in. long; and the passenger compartment, 20 ft. 5⅞ in. long.

The car is equipped with two GE-205, 600-1200 volt, box frame, oil-lubricated, series, commutating pole railway motors having a total of 200-hp. capacity. The motors are mounted with nose suspension directly on the axles of the forward truck. They are insulated for 1200 volts so that they may be interchanged, if desired, with the motor equipments on the cars of the Oregon Electric railway, which operates on the 1200-volt system. The generating unit consists of an 8-cylinder, 4-cycle gas engine of the 'V' type, direct connected to a 600-volt commutating pole electric generator, designed to meet the special conditions the service demands.

The body of the car is of the all-steel type of construction, except the seats and interior finish, which are of mahogany.



GAS-ELECTRIC MOTOR CAR, SPOKANE, PORTLAND & SEATTLE RAILWAY.

A rear open platform entrance with body and platform railings is provided. The bearings and treads and flanges of the wheels conform to MCB standards. The trucks are of the heavy spring bolster type with elliptic bolster and coil equalizer springs.

COMBINED WATER WHEEL AND ELECTRIC MOTOR DRIVEN COMPRESSOR

A novel hydro-pneumatic installation has recently been made by the Snowstorm Mining Co., operating in the Coeur d'Alene district, Idaho. The plant consists of a 300-hp. air-compressor, rope driven by a Pelton water wheel and an induction motor direct coupled and working either independently or in parallel with the water-wheel unit, when the latter rotates at 374 revolutions per minute.

Due to the variable water supply available for the wheel and the continuous operation required of the compressor, it was necessary to install a 250-hp. electric motor to help out, during the period that the water wheel was unable, from lack of water, to drive the compressor at the required load and speed.

Current for the motor is secured from a transmission line of a commercial plant supplying the district. Mounted on the electric motor shaft is a 46-in. diameter rope sheave which drives a 14-ft. sheave on the compressor. The compressor sheave is grooved for nineteen 1½-in. diameter manila ropes, and the sheave is cast with sufficient weight to obtain the requisite fly-wheel effect for the compressor's operation. The American system of rope transmission is employed, the tension sheaves and re-winders being placed above the driving ropes and located in such a manner as to conserve floor space and head room to the greatest extent possible.

The water-wheel equipment consists of a twin runner Pelton-Doble tangential water-wheel unit; one runner being approxi-

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mately 44 in. diameter, and capable of developing 325 hp. when running at a speed of 347 r.p.m. This speed also coincides with the full load speed of the induction motor. The other wheel is approximately 72 in. diameter and develops 250 hp. at a speed of 212 r.p.m. Both water wheels are keyed on the same shaft, which is extended and coupled to the electric motor shaft, carrying the driving sheave. One or the other wheel must develop the requisite power when running at its correct speed, in this event the idle wheel, the pressure water being shut off, simply rotates on the shaft without performing useful work other than providing additional fly-wheel effect for the installation. Both wheels never develop power at the same time.

The requirements of the plant call for the highest efficiency over a wide range of operating conditions, involving approximately a 300% fluctuation of the power water supply, and a variation of the compressor speed, hence the power required depending upon the demands on the air-line. It is necessary during certain times that 300 hp. be delivered to the compressor sheave when the latter rotates at 95 revolutions per minute.

If there is sufficient water available, the 44-in. Pelton wheel develops this power without assistance from the electric motor. Should the water supply be insufficient, current is applied to the electric motor to supply the deficiency. At other times, and over a period of several hours duration per day, the compressor output is reduced to an amount corresponding to 58 r.p.m. In this event the water for the 44-in. Pelton wheel is shut off and it rotates idly while the 72-in. Pelton wheel is allowed to develop the power, without assistance from the motor. While either wheel may develop its full power when operating a correct normal speed of 347 r.p.m. for the 44-in. wheel and 212 r.p.m. for the 72-in. wheel, quite a wide variation of speed below normal may be secured, hence a most flexible installation has been secured.

The novelty of this plant consists of the application of a variable speed, variable power tangential water-wheel unit to a constant speed induction motor, driving a compressor. The plotted efficiency curves of the water wheels are quite flat for a range of power between 220 and 300 hp. for the 44-in. wheel when rotating at 347 r.p.m., and for the 72-in. wheel between 160 and 230 hp. output at 212 revolutions per minute.

For slight reductions of speeds below normal the efficiency holds up remarkably well, as was predicted. These results are made possible through the type of ellipsoidal water-wheel buckets employed in conjunction with needle regulating nozzles. The latter discharge a perfectly circular solid jet under variations corresponding to full load of the respective wheels, down to about 10% of the maximum load. The hydraulic surfaces of the water-wheel buckets are ground and sharpened and the whole water-wheel unit especially developed for this particular plant.

To safeguard the water wheels from rupture due to centrifugal force, they are designed to operate under emergency run-away conditions of double the normal speed without stress to the parts beyond their elastic limit. The hydraulic apparatus was designed and constructed in the San Francisco works of the Pelton Water Wheel company.

THE following rule is said to have been given recently by the service manager of one of the tire companies: "Inflate the front tire to a pressure in pounds equal to 17 or 18 times their cross-section in inches, and the rear tires to 20 times their cross-section; thus 34 by 4-in. tires should have a pressure of about 70 lb. on the front wheels, and 80 lb. on the rear." It is to be hoped that the tires turned out are better than the rule, which seems almost absurd. The results given above are apparently obtained by using the diameter of the tube as the multiplier instead of the cross-section, and to make the pressure directly proportional to the diameter would give the smaller tubes less than their proper share.

EXPENSIVE LAND DEMANDS EFFICIENT PUMPING PLANTS

A proof that care and attention in purchasing pumping machinery for expensive lands is well worth the effort is shown by the performance of the pumping equipment recently installed at Covina near Los Angeles.

Here there are about 1100 acres of land drawing sustenance from three wells, two of which are 16 in. diameter, and the other 14 in. The wells are perfectly drilled, true in line and of ample depth to secure a full flow of water. Installed therein are deep well turbine pumps similar to illustration herewith, manufactured by the Krogh Manufacturing Co., at the head of which is F. W. Krogh, who has been in the practical irrigation business for over forty years. As a consequence, the Unruh company, which installed these plants at Covina, has one of the most modern and complete systems now in use on the fruit lands of California.

All the water is pumped from three wells, and is stored in two large reservoirs which together hold 3,000,000 gal. The reservoirs are built of heavily reinforced concrete, and distribute the water through a steel pipe system to all sections of the orchard land. The laterals for the delivery of the water are 8 in. diameter.

The turbine pumps discharge the water at the rate of 212 miners inches per minute, and are absolutely water balanced. The action of the water on the revolving impellers causes the shaft and rotating parts to balance on the film of water, thereby entirely eliminating end thrust and also practically discounting wear and tear on the equipment. This is the feature which is claimed for this particular type of pump, and means much to the irrigationist both from a power and absence of trouble standpoint.

To those who may be more than casually interested in this type of pumping machinery it may be well to describe more fully the pump installed in the 14-in. well. This pump is set down in the well 140 ft. below the surface, and raises 48 miners inches of water 40 ft. above the surface of the ground with very little attention and with perfect satisfaction. It is a 13-in. outside diameter Krogh deep well turbine pump direct connected to a Westinghouse vertical motor, and requires no pit.

The holdings of the Unruh company at Covina are a part of the famous old 'Lucky' Baldwin ranch, and this well known estate is now being transformed into a great orchard by means of wonderful irrigation work. It is, of course, only a part of the once waste lands of the west which have been transformed as if by magic by intensified irrigation methods.

To enable one to more fully understand the details or general construction of the Krogh deep well turbine pump the following will no doubt be of interest.

In general, the pump consists of a series of casings bolted together, each casing containing an impeller. All impellers are mounted on a single shaft. The water is drawn into the first casing at the bottom and is discharged into the next casing above, which in turn delivers the water to the third casing, and so on throughout the series, the water leaving the last or upper casing into the discharge column and is then forced to the surface or delivery point. The number of stages or impellers required depends upon the head against which the pump is to work, speed at which it is desired to operate the pump, and the capacity required.

The pump proper is located down in the well to such a depth that it is at all times submerged when working. A discharge column connects the pump and discharge head at the surface of the ground. This discharge column is of such size as is suitable to the capacity of the pump and is made in joints of about 10 ft. in length, every joint being flanged and provided with through bolts. At every flanged joint is a vertical shaft bearing. These bearings are held in a cast

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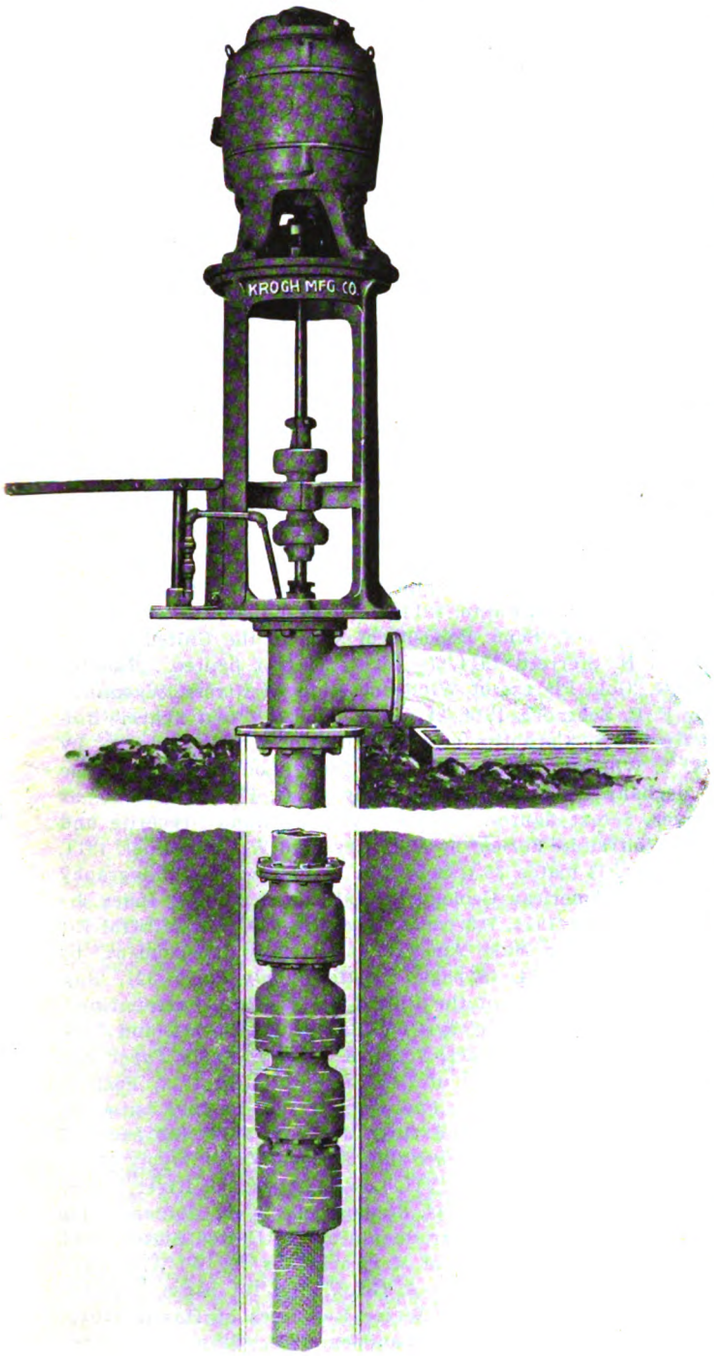
iron bearing spider. The spider is faced off on both sides and accurately centred with the flanges on the column. The flanges which form the joint are threaded and screwed on the casing pipe with faces rough. The length of casing is placed in a lathe and the flanges faced off and counter bored, thereby absolutely insuring that the spider and bearing contained



KROGH ELECTRICALLY DRIVEN DEEP WELL TURBINE PUMP.

therein are in perfect alignment and will not require lining up or adjustment. No matter how often the pump is taken out and reinstalled, the bearings are always in line.

The shaft which connects the pump shaft to the surface of the ground is of ample size, made in lengths about 10 ft. long, and is joined together with special steel couplings so arranged that they are quickly assembled. This shaft extends up through the pump head and is fitted with a suitable pulley to receive quarter turn belt if belt driven, or provided with flexible coupling if motor connected. A centrifugal oiling bearing of the belted type is provided on each side of the pulley, and a single centrifugal oiling bearing is provided below the flexible coupling on direct connected units. Contained in the centrifugal oiling bearing is a split clamp collar, beneath which is placed a plain roller bearing, to take the starting load only. As soon as the pump comes up to speed the automatic hydraulic balancing device with which the pump is provided, comes into action and sustains the weight of all the rotating parts by hydraulic pressure, the collar mentioned above rising away from the bearing. This balancing arrangement is automatic in its operation and requires no setting or adjustment. The suction opening of pump is provided with a strainer to prevent the entrance of large gravel or other solids which may clog the passages.

The lubrication of the vertical shaft bearings is positive and simple. A specially designed grease pump is furnished and mounted on the pump head, from this pump a pipe is led down along the shaft and is connected into each bearing, the bearing spider being designed to receive and support the grease pipe. Grease is placed in the pump and forced down through the pipe to the different bearings.

Soft grease lubrication is superior to any other method of lubrication, as the grease not only stays in the bearing longer than any kind of oil, but also prevents grit from entering the bearing.

On the shaft, immediately below and above each bearing, is placed a circular shield into which the end of the bearing projects. When running, these shields protect the ends of bearing against the entrance of grit.

This type of pump is so designed and constructed that anyone can readily install it correctly and with greater ease than any ordinary pumping installation. All joints being flanged, they require no further screwing up after shipment. Shaft is cut to proper length and fitted at the factory, bearings are so constructed that they align themselves, and all that is required is to lower each section into the well and bolt the next section to it and lower until pump is completely installed.

The foundation should be of concrete about 18 in. thick; foundation bolts should be set in short pieces of pipe so that they can be moved slightly and located according to foundation plan of the particular head used. Hence this class of work can be easily handled with a common chain tackle and tripod, if a regular derrick and windlass and blocks are not available. However, parties installing such equipment would do well to follow the manufacturers' directions and thus avoid trouble.

Book Reviews

PUMPING BY COMPRESSED AIR. By Edmund M. Ivens. John Wiley & Sons, New York. P. 232. Index. For sale by the *Mining and Scientific Press*, San Francisco. Price $3.

The direct application of compressed air for pumping liquids has come into greatly increased use during the past ten or fifteen years. While most of us are more or less familiar with pumps of the piston type using compressed air for power, it is with the air-lift that the most economical use of compressed air has been made. Such books as already have been written touching upon the use of compressed air for pumping have been general rather than specific with regard to the mechanics of the air-lift. As the author, by reason of his connection with the Ingersoll-Rand company, has had an exceptional opportunity to inform himself upon the finer points of design and performance, unusual interest in his work is natural.

In opening the discussion of this branch of the general

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subject, the author, after describing the various types of air-lift devised by the pioneers in the field as well as those of comparatively modern origin, gives also the various theories of the operation of the apparatus in full mathematical detail. Following this, the question of submergence is taken up. This is of prime importance to the successful operation of the air-lift, and is a subject that is incompletely understood by many engineers. The necessity for a high percentage of submergence is pointed out as requisite for successful operation under economical conditions, and at the same time as one of the factors that has militated greatly against a general adoption of this system of pumping. Tabulated data showing efficiency obtained with varying percentages of submergence are presented, the results being taken from tests made of wells operating under actual working conditions. The author, after discussing his own experience, states that no rule can be given as to what is proper submergence and that no formulæ can be devised that will serve even as an approximate guide. Evidently, at least this portion of the design of the air-lift system must still be left to the man of experience, who knows because he knows, and not why he knows.

The question of proper velocities is also given careful and thorough discussion in which the author has made due use of the work done by the various experimenters in this field. For the apparatus itself, a generous allotment of space has been given. Practically all of the known methods for which practical success has been obtained are described, and tabulated data presented for each under working conditions.

One should not lose sight of the fact that the air-lift is not the only means of pumping by compressed air. Pumping by direct action through pistons, the displacement pump, and the return air system are also described, both as to theory and methods for their application. The last three chapters are given to a discussion of compression generalities and compressors, a necessary adjunct to any work dealing with compressed air.

As a whole, this book is distinctly good, and while from a California standpoint it is to be regretted that the author has not given any data on the use of the air-lift for pumping crude petroleum, nevertheless it would appear ungracious not to be thankful for what has been given, rather than, like Oliver Twist, be asking for more.

Recent Publications

THE HIGHWAY MAGAZINE, September 1914. The California Corrugated Culvert Co., West Berkeley, California.

PERMISSIBLE ELECTRIC LAMPS FOR MINERS. By H. H. Clark. Technical Paper No. 75, U. S. Bureau of Mines. P. 21.

JENNISON-WRIGHT CO., Toledo, Ohio. Illustrated pamphlet and specifications for 'Kreolite Lug Blocks and Factory Floors.'

THE RESOURCES OF TENNESSEE. State Geological Survey. A. H. Purdue, state geologist; Wilbur A. Nelson, assistant. Nashville, Tennessee. Volume 4, Number 3.

IOWA STATE COLLEGE OF AGRICULTURE & MECHANIC ARTS, Ames, Iowa. Bulletin 34 of the Engineering Experiment Station on the use of Iowa gravel for concrete.

ELECTRIC CONTROLLER MFG. CO., Cleveland, Ohio. Illustrated pamphlet, showing the electrical apparatus used for the erection of the Quebec bridge.

BOARD OF HARBOR COMMISSIONERS, Los Angeles, Cal. Illustrated book covering the history, development, tributary territory, and other statistical data relating to the port of Los Angeles.

CLINTON HANDBOOK ON LATH AND PLASTER. Clinton Wire Cloth Co., Clinton, Massachusetts. This is more than a trade catalogue, and contains much valuable data concerning the practice of lath and plaster using metal lath. Typical specifications are given for all of the many various applications for plaster, both exterior and interior. P. 101, index.

ILLINOIS COAL MINING INVESTIGATIONS. Coöperative agreement between State Geological Survey of Illinois, Department of Mining Engineering, University of Illinois, and U. S. Bureau of Mines. Bulletin No. 4, 'Coal Mining Practice in District No. 7,' by S. O. Andros; Bulletin No. 5, 'Coal Mining Practice in District No. 1, Longwall'; Bulletin No. 6, 'Coal Mining Practice in District No. 5.'

NEW PUBLICATIONS U. S. GEOLOGICAL SURVEY

Professional Paper 85, 'Shorter Contributions to General Geology, 1913,' by David White, Chief Geologist, 1914, 99 pages, 14 plates, 7 text figures. *Professional Paper* 86, 'The Transportation of Débris by Running Water,' by G. K. Gilbert. Based on Experiments Made with the Assistance of E. C. Murphy, 1914, 263 pages, 3 plates, 89 text figures. *Bulletin* 541-F, 'Coal Fields in Rhode Island, Virginia, Kentucky, and Missouri,' papers by G. H. Ashley, M. R. Campbell, Charles Butts, and F. C. Greene, 1914, 89 pages, 5 plates, 2 text figures. *Bulletin* 541-J, 'Coal Fields in New Mexico and Utah,' papers by C. H. Wegemann and F. B. Clark, 1914, 74 pages, 4 plates, 2 text figures. *Bulletin* 549, 'The Shinumo Quadrangle, Grand Canyon District, Arizona,' by L. F. Noble, 1914, 100 pages, 18 plates, 1 text figure. *Bulletin* 574, 'Mining Districts of the Dillon Quadrangle, Montana, and Adjacent Areas,' by A. N. Winchell, 1914, 191 pages, 8 plates, 16 text figures. *Bulletin* 577, 'Geology of the Phosphate Deposits Northeast of Georgetown, Idaho,' by R. W. Richards and G. R. Mansfield, 1914, 76 pages, 14 plates, 3 text figures. *Bulletin* 578, 'The Iditarod-Ruby Region, Alaska,' by H. M. Eakin, 1914, 45 pages, 6 plates, 1 text figure. *Bulletin* 580-F, 'Some Deposits of Mica in the United States,' by D. B. Sterrett, 1914, 71 pages, 34 text figures. *Bulletin* 580-G, 'Gold Placers of Wind and Bighorn Rivers, Wyoming,' by F. C. Schrader, 1914, 21 pages, 1 plate, 1 text figure. *Bulletin* 580-H, 'Carnotite near Mauch Chunk, Pennsylvania,' by E. T. Wherry, 6 pages. *Bulletin* 580-I, 'Lode Deposits of the Alleghany District, California,' by H. G. Ferguson, 1914, 32 pages, 8 text figures. *Bulletin* 583, 'Colorado Ferberite and the Wolframite Series,' by F. L. Hess and W. T. Schaller, 1914, 75 pages, 14 plates, 35 text figures. *Bulletin* 584, 'Bibliography of North American Geology for 1913,' with Subject Index, by J. M. Nickles, 1914, 183 pages. *Bulletin* 599, 'Our Mineral Reserves—How to Make America Industrially Independent,' by G. O. Smith, 1914, 48 pages. *Water-Supply Paper* 321, 'Surface Water Supply of the United States, 1912, Part I, North Atlantic Coast Basins,' by C. C. Babb, C. C. Covert, and J. G. Mathers, 1914, 240 pages, 3 plates. *Water-Supply Paper* 325, 'Surface Water Supply of the United States, 1912, Part V, Upper Mississippi River and Hudson Bay Basins,' by A. H. Horton, W. G. Hoyt, and H. J. Jackson, 1914, 193 pages, 2 plates. *Water-Supply Paper* 327, 'Surface Water Supply of the United States, 1912, Part VII, Lower Mississippi River Basin,' by Robert Follansbee, 1914, 84 pages, 2 plates. *Water-Supply Paper* 328, 'Surface Water Supply of the United States, 1912, Part VIII, Western Gulf of Mexico Basins,' by W. W. Follett, Robert Follansbee, and G. A. Gray, 1914, 121 pages, 2 plates. *Water-Supply Paper* 336, 'Water Resources of Hawaii, 1912,' by C. H. Pierce and G. K. Larrison, 1914, 392 pages. *Water-Supply Paper* 339, 'Quality of the Surface Waters of Washington,' by Walton Van Winkle, 1914, 105 pages, 2 plates, 1 text figure. *Water-Supply Paper* 345-E, 'A Method of Determining the Daily Discharge of Rivers of Variable Slope,' by M. R. Hall, W. E. Hall, and C. H. Pierce, 1914, 15 pages, 2 text figures. *Water-Supply Paper* 345-F, 'The Discharge of Yukon River at Eagle, Alaska,' by E. A. Porter and R. W. Davenport, 1914, 13 pages, 2 plates, 2 text figures. *Water-Supply Paper* 346, 'Profile Surveys in the Basin of Clark Fork of Columbia River, Montana-Idaho-Washington,' prepared under the direction of R. B. Marshall, Chief Geographer, 1914, 6 pages, 3 plates.

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Construction News Summary

Condensed From Our Daily Construction News Service.

CALIFORNIA

ARCADIA—A $150,000 bond issue for constructing oil macadam roads within city limits was carried. Mark Ehle is city engineer.

AZUSA—Election will be held this month to vote on $35,000 of bonds for new water works, and $20,000 for lighting plant.

BENICIA—City Trustees grant A. D. Bowen an electric railroad franchise over city streets to connect Benicia and Vallejo. A line to Winters is also proposed.

EXETER—The Tulare Power Co. has been granted permission to erect an 11,000-volt distribution line from northwest corner of Chestnut and F streets north on F street.

FRESNO—President Phillips, Chamber of Commerce, announces that good roads bond issue will not be placed before voters next November. Plans of J. C. Thayer, architect, for Jefferson School annex on Diamond street have been accepted. ——Plans for installation of a pumping plant and one or more mains to irrigate Roeding park, have been partly completed at a conference between Park Commissioners J. S. Jones, Charles Chambers, secretary of Board of Park Commissioners, and Henry Roeding, Foxcroft building, San Francisco. Plans have been ordered for installation of hydrants at intervals of 100 ft. throughout entire park. Temporary system will probably use discarded hose from fire department.——Fresno Interurban Railway Co., J. B. Rogers, president, proposed extensions to Clovis is said to be assured. Company has borrowed $250,000 from a San Francisco trust company. Line will be 10 miles long; construction to start at once.——Summit Lake Investment Co., A. D. Cranor, manager, Griffith-McKenzie building, states that work will be done on extensive reclamation and canal work near Lenore, 28 miles from Fresno. Improvements to cost $150,000. Twelve miles of canal will be constructed.——Fire Chief Wintermute and City Electrician Robinson recommend doing away with present fire-box system and the substitution of one with 300 fire-boxes instead of only 25. Matter is under consideration by City Council. Recommendation also includes a fire-proof headquarters for entire city system.——A. Allen awarded contract for remodeling of Short building at $9560. Marble stairway will be constructed.——Bids will be received by Board of Supervisors until November 6 for constructing Dunlap cut-off road, 2.9 miles from old Millwood road east. Survey and estimate call for grading to cost about $800, new road to cost $5400, and 75-ft. bridge to cost $600, or $1400 if concrete piers are used.——James L. Daley was awarded contract at $12,490 for the erection of the new Jackson school, according to the plans prepared by architect Ernest J. Kump.

GARDEN GROVE—Garden Grove City Water Co. has been incorporated with $25,000 capital, and will install pumping plant, storage tank, and new distributing lines. F. H. Cloyes, secretary.

GLENDORA—Plans are being prepared by F. G. Dessery, Central building, Los Angeles, for water works improvements, to cost $50,000, to include distributing system, pumping station, etc. Bids for construction will be received in February or March.

INDIO—Voters have asked Supervisors for permission to vote $65,000 bonds for local road improvements and county surveyor has been appointed engineer to prepare plans.

LENORE—The Summit Lake Investment Co., Griffin-McKenzie building, Fresno, plans to do extensive reclamation and canal work on the Laguna de Tache Rancho lands near Lenore. Estimated cost $150,000. A. C. Cranor of the Land Department will be in charge of the project.

LOS ANGELES—Hermosa Beach Water Corporation asked permission of State Railroad Commission to purchase plant of the Hermosa Beach Water Company and to issue $80,000 in bonds. Corporation is reorganization of latter Company and about $15,000 of the new bond issue will be spent in improvements.——George B. Curtis was awarded contract by Board of Public Works for paving Sapphire street at $7319.19. Board of Public Works awarded contract to S. M. McCray at $9021.92 for improvement of Alvarado street, near Glendale avenue.——The Los Angeles Silica Corporation will construct a 6000-ft. aerial tramway from its quarries to the railroad at San Fernando. J. A. Fairchild, manager.——Southern Pacific Railway Co. has awarded contract for construction of reinforced concrete train sheds at Arcade depot, to Van Sant-Houghton Co., Hooker & Lent building, San Francisco, at $32,011.——City Engineer Homer Hamlin has presented ordinances of intention to construct sanitary sewers in following districts: Sixth street, Beaudry avenue, Brighton avenue, Townsend, Aurora, and Fiftieth streets.——Rogers Bros Co., 350 Merrick street, awarded contract at $20,750 for macadam paving in Road District No. 70, between Downey and Bellflower, work consisting of 7145 cu. yd. excavation, 18,808 ft. shaping, 13,353 tons rock, 7.1 cu. yd. concrete, 120 ft. 180-in. reinforced concrete pipe; county furnishes rock and oil. Other bidders, Brashear-Burns Co., $21,830; Fred Hoffman, $22,200; M. S. Cummings, $31,031.——Fairchild-Gilmore-Wilton Co. have been awarded contract at $11,199.65 for improving Camerford avenue. Work consists of 1190.2 lin. ft. grading, 35,706 sq. ft. asphalt-concrete paving, 2380 lin. ft. cement curb, and 11,902 sq. ft. cement sidewalk. California-Arizona Construction Co. bid $16,186.56.——Leo Miletich has been awarded contract at $50,000 for constructing sewer in Brent street. Other bidders: R. A. Wattson, $54,987; R. M. Nikcevich, $87,300; Malgenovich & Gillespie, $65,000; Peter S. Tomich and John Urkopina, $69,000.——C. J. Kubach Co., 727 Van Nuys building, secured contract at $115,000 for erection of 5-story and basement class B bank and office building at Pine avenue and Broadway, Long Beach, for Mrs. L. Hauerwauss. John P. Krempel and Walter E. Erkes, architects, 415 Henne building.——W. H. Holabird, receiver for the California Development Co., room 400, 626 South Spring street, has been given authority to purchase a dredge.——George H. Owland, O. T. Johnson building, awarded contract at $118,122.93 for improving Moneta avenue, between Slauson and Manchester avenues. Work consists of 525,200 sq. ft. asphalt paving, 17,900 ft. curb, 203,000 sq. ft. sidewalk, 17,963 sq. ft. concrete gutter, 7545 sq. ft. granite gutter, 1781 ft. special curb; also reinforced concrete culvert which was bid at $1120, and extension to reinforced concrete culvert for $450. Other bidders were Tryon & Brain, $120,926.72; Ford & Stout, $128,821.69; Fairchild-Gilmore-Wilton Co., $127,197.52; California-Arizona Construction Co., $211,693.90. ——Edgar T. Wheeler Co. awarded contract at $6.46 per pile for driving 400 piles along Arroyo Seco. Other bidders: Russell-Greene-Foell Co., $6.47; Mercereau Bridge & Construction Co., $8.35; Mesmer & Rice, $9.25.——Bids will be received by U. S. Engineer, Major R. R. Raymond, 723 Central building, until 11 a.m., October 22, for furnishing cement, sand, and crushed rock for fortification construction work at San Pedro; 14,500 bbl. portland cement, 9700 tons sand, 19,000 tons crushed rock required.——The Fairchild-Gilmore-Wilton Co. has been awarded contract at $41,451.50 for paving with sheet asphalt the approach to municipal dock No. 1 from San Pedro street to the end of the dock. Bryant & Austin bid $42,969.40. California-Arizona Construction Co. bid $45,825.10.——The City Council has authorized the Board of Public Works under emergency provision to purchase from the Pacific Portland Cement Co. about 1800 bbl. of portland cement at a price of $2.55 per bbl. The City Engineer has advised that an allowance of $4000 made in the present budget for the purchase of rock for repairing San Fernando road had better be used for widening the road to 18 ft. with asphalt concrete, and placing over the entire roadway a surface of asphalt.——The City Engineer has presented to the Board of Public Works plans and profile for proposed sewer in 63rd street, outside the city limits.——The Harbor Commission has asked the City Engineer to prepare estimates of the cost of dredging an area of shallow water at the northerly end of the harbor turning basin and depositing the dredgings on land near the Mormon Island channel wharf. The area to be dredged will be about 600 ft. wide by 1800 ft. long.——The Board of Public Utility has approved the application for a franchise for the construction of an incline railway for Mount Hollywood in Griffith park, made by Col. Louis Ginger. The application also has been approved by the Los Angeles Park Commission. The City Council has confirmed the map of the assessment district for the opening and widening of Long Beach avenue from Washington street to Slauson avenue.——City Engineer Homer Hamlin has presented specifications to Board of Public Works for furnishing 16,000 bbl. of 75% road oil, to be delivered on streets by pressure sprays from motor trucks.——U. S. government will construct an immigration station here.——J. E. Haddock, 757 N. Chester avenue, Pasadena, awarded contract for grading, cement work, and macadamizing Road District No. 75 at $22,643.15.

MERCED—Plans for three reinforced concrete bridges, prepared by A. E. Cowell, county surveyor, have been approved and bids will be received by Board of County Commissioners until 10 a.m., November 11.——City Trustees ordered street lights installed in 19th and H, 13th and P streets, and in alleys between J and K, 16th and 17th streets.

MODESTO—Bids will be received by H. Benson, Clerk of Board of Supervisors, Stanislaus county, until 10 a.m., November 10, for construction of a bridge over Briggs ditch. Estimated cost $6000. City Council orders paving of alleys between 13th and 14th streets in blocks between I and J, and J and K. Also paving the alleys between 10th and 11th, and 11th and 12th streets in blocks G and H streets. Also to pave the city's portion of the intersections at 9th street and K, L, M, N, O, and P

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streets.——J. A. Orr has been appointed a director in division No. 2 of the Turlock irrigation district.

OAKLAND—The Board of Supervisors has approved contract and bond from D. U. Toffelmier for macadamizing a portion of Crow Canyon road. The Board has also approved contract and bond from Cotton, Risdon & Co. for the construction of protection work on the Arroyo del Valle on the county road No. 2578.——The Board of Supervisors has awarded contract for the repairs to three tidal canal bridges to the Pacific Construction Co. at a total price of $19,678.09.——Charles P. Weeks, architect, has submitted the following estimates for cost of new buildings at the county infirmary: Women's day hall and arcade, $41,548; men's day hall and arcade, $72,410; domestic building, $101,164; ten dormitories, $250,560; necessary grading work around this group of buildings, $20,000; total, $485,682.——Bids are being received by Commissioner of Streets, W. J. Baccus, for material for corrugated iron culverts for street department for remainder of fiscal year 1914-1915.——Torrance S. Peterson has been granted permission to construct a culvert in Leon creek through his property near Havenscourt tract.——R. M. Henningsen has been appointed harbor engineer and will assume office immediately in the Harbor building. Mr. Henningsen designed the docks at Tacoma, and has been employed by the U. S. government in engineering work and several years in a similar capacity with the Northern Pacific railroad.——Plans are being prepared by George W. Patton, 2126 Emerson street, Berkeley, for a 7-story brick and steel hotel to be erected at 10th and Clay streets, by O. J. Meade, to cost $150,000.

RICHMOND—Richmond Industrial Commission, after consulting with engineers, has decided to dredge entrance to inner harbor to a depth sufficient for ocean vessels at municipal wharf, and to do more dredging on inner part of the harbor.——Southern Pacific Co. has received orders from the State Railroad Commission to immediately commence the erection of freight and passenger depots in this city. Plans must be presented for approval within sixty days, and depots completed within six months. Freight depot will cost approximately $14,000, and passenger depot $6000.——The Contra Costa County Board of Supervisors will conduct a hearing on November 16 to discuss a proposal to issue $1,000,000 in bonds for the construction of 40 miles of boulevard through the southern portion of Contra Costa county.——Property owners have protested against the use of bitulithic paving in 7th street. Standard macadam will be used instead.——Bids have been called until October 13 for paving 16th street with asphalt macadam.——Bids received for lavatory equipment for Lincoln school as follows: M. Morton, $5417; M. B. Roberts, $5745; James Cruikshank, $6201.——It is stated that a new school building, to cost approximately $50,000, will be built to supplement the Stege school——A. W. Anson, of Santa Monica, has been awarded contract for construction of roundhouse for the Santa Fe railway near Adams wharf. The structure will accommodate two freight engines, and have a machine-shop, etc.——Construction engineers of the Shell Co. are at Martinez looking over 400 acres purchased there for new refinery. Work on the pipe-line has been started. Tenants on refinery site have been notified to vacate.——Balfour Guthrie Investment Co. has purchased the Turner Oil Co. for $1,500,000 cash. It is understood that the purchase is made on behalf of one of the Shell-Royal Dutch interests.

SACRAMENTO—The California Highway Commission, Forum building, will open bids on November 9 for the following sections of the state highway: Colusa, from Williams to Colusa, 8.4 miles of portland cement concrete; Glenn, from the southerly boundary of the county to Willows, 8.5 miles of portland cement concrete; Solano, from the point 2½ miles south of Cordelia to Fairfield, 8.1 miles of portland cement concrete; Imperial, from Coyote Wells to Dixieland, 11.7 miles of portland cement concrete.——The following bids have been received by the Board of Supervisors for construction of a bridge across Arcade creek: J. H. Wells, $3546; Ross Construction Co., $3590; A. McDonald, $3698; and A. Teichert & Sons, $3650. Bids referred to Contract Committee.——The United States Cast Iron Pipe Co., R. W. Martindale, Monadnock building, San Francisco, offers to take over entire construction of new high-pressure water system and market the bonds if this Company is allowed to do all of the work. Estimated cost, $1,329,000, of which about $33,000 worth of bonds have already been sold.——City Commissioner of Finance, F. E. Shaw, intends to push action toward the letting of a contract for the $208,000 City Hall of Justice, so that work may be commenced soon.——Advisory Board of State Engineering Department awards contract to Enoch J. Hunt, of Alameda, for construction of a strip of road in San Luis Obispo county upon his bid of $46,605.65. Engineer's estimate was $53,779.17.——State Highway Commission awards following contracts: A. C. McClean Construction Co., of San Francisco, from southerly boundary of Kern county to Rose station; bid, $68,004; engineer's estimate, $86,125.23. Elsmore & Jacobs, of Eureka, 4.3 miles from Leleta to Beatrice, Humboldt county; bid, $18,777.80; engineer's estimate, $28,809.67. William Crowley and T. E. Cloney, of Eureka, 3.7 miles from Shively to Jordan creek, in Humboldt county; bid, $28,624.98; engineer's estimate, $36,294.50. Palmer & McBride, of San Francisco, 5.9 miles from the easterly boundary of Alameda county to Altamont; bid, $38,023; engineer's estimate, $45,879.25.——The Commission passed a resolution directing the State Engineer to construct the unit in Santa Barbara county over Serena Gap. Bids were all unsatisfactory.——Commission declares 8.4 miles from Williams to Colusa, in Colusa county, to be state highway; also 11.7 miles in Imperial county between Wells and Dixieland, and 3.6 miles in Orange county on the easterly boundary. It is estimated that these three units will cost aproximately $250,000.——Following bids received by State Highway Commission for approximately 71 miles of road, to cost about $500,000, as follows: 6.8 miles of road in Sacramento county, starting near Folsom; A. W. Garrill, of San Francisco, bid $39,141; engineer's estimate, $43,171.25. Santa Barbara county, from David to Orcutt, 3.6 miles; engineer's estimate, $20,333.67; material furnished by state, $22,899.45; F. Rolandi, San Francisco, $18,751.50. Solano county, from Vacaville to Batavia, 8.2 miles; estimate, $48,295.50; material, $34,669.28; P. L. Burr, San Francisco, $44,679. San Luis Obispo county, from San Luis Obispo creek to Cuesta, 3.6 miles; estimate, 87,365; material, $56,736.10; J. W. Colback, San Diego, $71,989.20. Humboldt county, from Shively to Jordan creek, 3.7 miles; estimate, $36,294.40; material, $9422; Crowley & Cloney, Eureka, $28,724.-98. Santa Barbara county, from Zaca station to Los Alamos, 8.7 miles; estimate, $68,841.87; material, $61,536.56; Rogers Brothers Co., of Los Angeles, $62,679.50. Imperial county, from Meyers creek to Coyote, 6 miles; estimate, $79,436; material, $25,922.25; J. W. Colback, of San Diego, $68,145.-90. San Luis Obispo county, from Atascadero creek to Paso Robles, 10 miles; estimate, $53,779.17; material, $5355.95; Enoch J. Hunt, Alameda, $46,605.65. Santa Barbara county, from Stony creek to El Capitan, 10.2 miles; estimate, $93,487.06; material, $8691.70; C. H. Hudson, Los Angeles, $79,191.40.——It is rumored that the Central California Traction Co. may move its head offices and shops, now located at Stockton, to this city.——California Highway Commission, Charles C. Carleton, Acting Secretary, will receive bids until 2 p.m., November 9, for constructing 8.4 miles of portland cement highway to be built in Colusa county from Williams to Colusa; for constructing 8.5 miles of portland cement concrete highway in Glenn county from southerly boundary to Willows; for constructing 8.1 miles of portland cement concrete highway in Solano from a point 2½ miles south of Cordelia to Fairfield; for constructing 11.7 miles of portland cement concrete highway in Imperial county, from Coyote Wells to Dixieland.——C. J. Matthews bid $56,851 for construction of trunk sewer line from new sump pumping station on Riverside road. Sewer will be 9½ ft. in diameter and 10 in. thick, of reinforced concrete, and will extend 2226 ft. Engineer's estimate was $62,000.——Plans are now under way for construction of a large dam near Cache creek, near Hennigan property at vicinity of Woodland, for irrigating about 440 acres. County Surveyor C. M. Ashley interested.——County Surveyor Drury Butler states that riprap work, which he recommends to be substituted for sheet metal piling in foundation of Twelfth Street bridge, will cost approximately $6000, which is twice the cost of metal piling.——Property owners in Fair Oaks, Orangevale, Rosedale, and Carmichael Colony, contemplate forming American River irrigation district. F. Glen Andrus, chairman.

SAN BERNARDINO—County Highway bonds to the extent of $1,750,000 and hospital bonds to the extent of $150,000 have been voted. About 400 miles of road will be improved; 187 miles with concrete paving.——Engineers, officials, and property owners, as a result of a recent conference held in County Surveyor Bright's office, have decided on a definite plan for conservation of flood-waters of Lytle creek, the formal report having been made by Engineer F. C. Finkle of Los Angeles. Plans consist of a series of five dams and many canals and dikes.——W. D. Bohan (463 G street, San Bernardino) was lowest bidder and awarded following contracts: For improving portion of Sixth street between B and I streets, $23,335.43; units were 10c. per sq. ft. for paving with 4-in. cement concrete base and oil wearing surface, 11c. per sq. ft. of cement concrete gutters, and $123.50 for culverts complete. For improving portions of F street between Rialto and Second streets, $4760.28; units, 10c. per sq. ft. paving with 4 in. cement concrete base and oil wearing surface, 11c. per sq. ft. of cement concrete gutters, and $544.50 for culverts complete. For improving portion of Court street between F and E streets, $1469.88; unit, 11c. per sq. ft. for paving with 4-in. cement concrete base and oil wearing surface, 11c. per sq. ft. cement concrete gutters.

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SAN DIEGO—Council has adopted plans for constructing asphalt paving and ornamental lighting posts on Fourth street between A and Ivy streets.——Plans and specifications for filtration house and tanks to be constructed on lower Otay dam have been completed and filed with City Council. City Clerk will be instructed in a few days to advertise for bids for construction work. Water bond issue set aside $60,000 for filtration plant.——Trounce & Stoecker, Owl Drug building, San Diego, and 623 San Fernando building, Los Angeles, have been awarded contract at $38,440 for erecting the concrete and hollow tile school building at El Cajon and Meade avenues, according to plans prepared by architect, Theo. C. Kistner.——The California Railroad Commission has authorized the expenditure of $219,956 by the San Diego & Arizona Railroad for steel and track material; also $203,966 for other material and equipment. The contract has been approved by the Commission for the purchase of a passenger coach and one all-steel combination car at the cost of $26,710. The San Diego & Arizona Railroad was promoted by the Spreckels interests and is now under construction between Seeley in the Imperial valley and San Diego.——The Los Angeles & San Diego Railway has been authorized by the Railroad Commission to issue bonds in the amount of $250,000 for the purpose of electrifying its road to La Jolla and to rehabilitate its roadways and tracks and buildings. The amount applied for was $285,000. B. F. Babcock is owner of the road.——J. T. Butler, clerk of the Board of Supervisors of San Diego county, has called for bids until 2 p.m., November 4, for general contract, plumbing, and steam heating, electric wiring and fixtures, tile work and painting; all for alterations in the county hospital. He has also called for bids until 11 a.m., November 5, for the construction of a jail building at Oceanside, San Diego county.——City Council has directed finance department to advertise for material to building 3000 ft. of steel flume on Dulzura conduit proposition. The department was also directed to advertise for bids for construction of a filtration plant at Lower Otay dam, which will cost approximately $60,000.——City Council accepts the bid of the Western Pipe & Steel Co., of Los Angeles, for furnishing 40,500 ft. of riveted steel pipe and fittings; upon bid of $101,072.——J. T. Butler, County Clerk, will receive bids until 11 a.m., November 5, for the construction of a jail building at Oceanside, San Diego county. Bids must be accompanied by certified check for 5% of amount of bid.——The Escondido Mutual Water Co. has made application to the Board of Supervisors for a franchise to build an electric transmission line from the reservoir on San Luis Rey river to Escondido.——Sunset Telephone Co., C. F. Mason, superintendent, has set aside $50,000 for immediate improvements.——City Council directs the Department of Finance, Ways and Means to advertise for steel pipe for constructing new pipelines from Bonita.——City Council receives following bids for grading and paving Mississippi street with decomposed granite: C. L. Hyde Construction Co., 75c. excavating, 1c. embankment, 4¾c. paving, 12c. sidewalks; Pioneer Truck Co., 48c. excavating, 1c. embankment, 5c. paving, 12½c. walks; G. R. Daley, 55c. excavating, 5c. embankment, 4c. paving; 13c. walks, 38c. curbs; John Engebretson, 2c. excavating, 41c. embankment, 4.2c. paving, 13¾c. walks, 40c. curbs.——Advance Construction Co., city, awarded the hauling of 1000 tons of cement and 1000 tons of miscellaneous supplies to Barrett & Morena for water department at $5.95 per ton.

SAN FRANCISCO—Board of Public Works has authorized improvement of 47th avenue near Balboa street under contract by private parties. Central strip of vitrified brick or concrete is to be laid from Balboa street to a point 300 ft. southerly from the avenue, and asphalt on the remainder of the roadway. The improvement of Falcon avenue, near Danvers street, has also been authorized.——The contract for paving the interior of the Stockton-street tunnel has been sublet to the Fay Improvement Co., Phelan building.——The Board of Supervisors has approved plans for the new public library building in the Civic Center.——The following appropriations have been made by the Board: For switchboard at central fire-alarm station, $7696.80; addition for construction of Potrero avenue line of Municipal Railway, $10,893; for paving yard and for benches at Polytechnic High School, $2924; additional for Junipero Serra boulevard, $2609; for fire escapes, Burnett school, $2693.——The Board of Public Works has granted permits to improve streets under private contracts as follows: Circular avenue between Staples and Flood avenues, grading and construction of curb, sidewalks, catch-basins, culverts, and asphalt pavements. Fortieth avenue between Geary and Clement streets, grading and construction of macadamized pavement, and the same on the south half of Clement street between 39th and 40th avenues, and intersections thereof. California street between 32nd and 33rd avenues, by construction of concrete curbs and asphalt pavements; north half of 22nd street between San Bruno avenue and Vermont street, by construction of concrete curbs and asphalt pavement with 7-ft. strip of basalt. St. Rose's avenue between Blake and Cook streets, by construction of curbs and asphalt pavement on north half and same improvement on north half of same street between Blake and Cook streets. San Francisco street between Polk and Van Ness avenue; constructing granite curbs and asphalt pavement and sewers. Virgil alley, between 25th and 26th streets, by construction of asphalt pavement; Valley street between Noe and Sanchez streets, by grading and construction of concrete curbs.——Orders have been received by the Shell company, Kohl building, San Francisco, to proceed with the erection of their oil refinery. Specifications have been prepared and will be sent out to bidders.——Board of Public Works rejects bid of Hans Pederson for construction of Twin Peaks tunnel on account of irregular bid.——City Engineer's Office reports that a main traffic artery down the peninsula, by way of San Bruno avenue and Bay Shore line in San Mateo county, will probably be constructed, as legal difficulties have been removed.——Plans are being prepared by City Engineer M. M. O'Shaughnessy for structural steel for municipal car barns to be erected at Potrero avenue at a cost of $150,000.——Bids will be received about December 1 for construction of the proposed 3,000,000-gal. capacity reservoir in Lincoln Park, to include 22,000 yd. of excavation and asphalt concrete lining. H. W. Shimer, assistant city engineer.——Board of Harbor Commissioners award contract to Healy-Tibbitts Construction Co., 9 Main street, San Francisco, for construction of pier No. 16. Bid, $108,720. Award contract to San Francisco Bridge Co. for construction of pier No. 18. Bid, $111,800.——California Trona Co., owner of potash deposits near Searles, in San Bernardino county, has made application through Trona Railway Co. to State Railroad Commission to issue $1,000,000 in bonds. Permission has been granted, provided the American Trona Co. guarantees payment of interest and principal.——Commission has granted application of Northern California Power Co., Consolidated, to issue 5000 shares of 6% cumulative preferred stock; $175,000 of this money will be used for extension and betterments. Properties will be appraised before December 1.——Plans have been completed by City Department of Architecture, and turned over to Board of Public Works, for central power station which is to be erected in Civic Center to supply light and power to the various buildings. The buildings will be erected at the corner of McAllister and Larkin streets, and will be of reinforced concrete construction. About $75,000 is available for this project.——Oakland, Antioch & Eastern railway is authorized by Railroad Commission to issue $105,000 first mortgage, 5%, 30-year bonds. Collateral secured by a one-day note in the sum of $62,500.

SAN JOSE—Bids have been called by Henry A. Pfister, Clerk of the Board of Supervisors of Santa Clara county, until 11 a.m., November 4, for the construction of a reinforced concrete bridge over Stevens creek at the Montebello road.——Bids have been called by Elton R. Shaw, president of the Board of Police and Fire Commissioners, until Friday, November 6, at 7:30 p.m., for furnishing 1000 ft., more or less, of single or double jacket 2½-in. fire hose, and 1000 ft., more or less, of relining for old 2½ and 3-in. hose. Address Guy K. Brown, secretary of the board, City Hall, San Jose.——City Clerk, Roy Walter, will receive bids for 200 tons of old sheet asphalt to be used in repairing streets.——County Board of Supervisors received lowest bid for construction of reinforced concrete bridge to cross Los Gatos creek, from M. E. Killam, at $6557. The bid of the Federal Construction Co. to improve University avenue for 11.9c. per foot was rejected.——The American Magnesite mines, easterly part of Santa Clara county, have started building an $8000 road from mining properties to connect with Alameda County road near Livermore. Eleven miles of road will be constructed, so that ore may be hauled by motor trucks. James Cummins interested.

SANTA BARBARA—County Commissioners have informed State Highway Commission that county stands ready to negotiate state bonds sufficient to complete the Bicknell-Los Alamos section, and Los Alamos-Zaca station section of state road. For this work the state asks $175,000.——Munoz & Munoz, 800 Central building, Los Angeles, has been awarded contract at $11,325 for construction of Salinas Creek reinforced concrete bridge on East boulevard. Other bidders: C. F. Edwards, $11,850; Magnus Johnson, $12,282; Mesmer & Rice, $12,546; Russell-Greene-Foell Co., $12,827; Boardman Construction Co., $13,383.——Boardman Construction Co., 1107 Story building, Los Angeles, has been awarded contract at $11,890 for construction of reinforced concrete Aliso bridge on East boulevard.——F. F. Flournoy, County Surveyor, is preparing plans for constructing steel and concrete bridge over the El Guamada, to be 400 ft. long and 77 ft. wide. Cost, $45,000. Plans are being prepared for construction of a bridge over Arroyo Hondo for the county, to be 625 ft. long, 80 ft. wide, and cost

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about $75,000.——Following men have been named as members of County Highway Commission: Hugh S. Kelley, of Santa Maria; W. A. Lewis, Lompoc; and George M. Williams, of Hope.——Following contracts for bath-house have been awarded: General contract, E. O. Engstrum Co., of Los Angeles; iron work, Los Angeles Steel & Iron Works, and Baker Iron Works; plumbing and heating, Thomas A. Haverty; total bids aggregate $60,000.——Unit Brick & Tile Co. awarded contract for furnishing material for walls and roof of H. E. Bothin residence at Montecito. Materials will cost approximately $12,000. Building will cost about $35,000.——F. R. Ritchi Co., of San Francisco, refused to sign contract for paving Valerio street because of technical error in specifications. Work will probably be readvertised.

SUNNYVALE—City Clerk has been instructed to advertise for bids for a water works plant.

SUSANVILLE—The Baxter Creek Irrigation Co. will extend its irrigation project; a surveying party has been put on the ground so that contract may soon be ready for advertising for bids.——Board of Trustees ordered concrete bridge constructed across Susan river near Southern Pacific depot. Plans and specifications will be prepared at once.

VISALIA—Tulare County Highway Commission files report and makes recommendations for network of highways to consist of 310 miles of roadways, four-fifths of which will be concrete. Bond issue recommended for $1,500,000.——California Hog & Cattle Co. incorporates for $1,000,000 to launch on an extensive scale of raising stock, dairy products, etc. Incorporators, L. A. Nares, J. A. Denham, L. M. Drew, A. B. Kerr, H. P. Brown, all of Fresno. John McLaughlin, 1421 K street, is business agent. Company will construct dairy and creamery next spring, and later will erect plant for curing and packing of meat.——Axel Allen has secured permission to erect two-story brick building at B and San Benito streets, to be occupied by the San Joaquin Baking Co. Estimated cost, $12,000.——City Trustees have issued a call for a bond election for $120,000. Of this amount $12,000 is for buying an auto chemical and auto hose wagon for fire department. The remaining $108,000 is for extension of sewer system and purchase of a sewer farm.

VENICE—Special election will be held November 6 to vote bonds in the amount of $35,000 for extending the salt water mains and sewer improvements.

OREGON

BAKER—Commissioner Finley authorized to engage service of engineer to determine location of sanitary sewer.——Commissioner Finley has been directed to secure necessary information, employing, if required, the services of an engineer to present data on cost of establishing a new lighting plant or enlarging present equipment.

HOOD RIVER—Andrus & Bode Co., Portland, submitted low bid for reconstruction of headworks at intake on East fork of Hood river, $19,160. George R. Wilbur, secretary, East Fork irrigation district, 6 Hall building.——Stanley Smith Lumber Co. will start work immediately on rebuildng plant destroyed recently by fire. Estimated cost $65,000.——Contract for construction of Division No. 1 of General Sewer District No. 2, was awarded to Transfer & Livery Clay Pipe Co., $5322. P. M. Morse, City Engineer.

MEDFORD—Steps toward securing irrigation in Rogue River valley, entailing expenditure of over $2,000,000, will be taken by the Fruit Growers' League, the Rogue Land Canal Co. agreeing to furnish water for 55,000 acres, provided necessary number of contracts can be secured upon 20-year contract. Rogue Land Canal Co. is owned by Pat Welsh and R. K. Neal, of Spokane.

NYSSA—A petition is being circulated to be submitted to the taxpayers of Malheur county for the purpose of voting bonds in the sum of $30,000. If the bonds carry, a bridge will be erected across the Snake river.

OREGON CITY—Engineer H. A. Rands, of Hurlburt & Rands, Portland, has submitted report to Council on proposed pipe-line from the south fork of Clackamas river. Three lines have been suggested and surveyed. Distance is approximately 25 miles and estimated cost is $250,000. Work also calls for reservoir with a capacity of 5,000,000 gal. Bids will be asked soon.——Permit has been issued by war department to Frank Busch to construct a dock on Willamette river between 11th and 12th streets.

PORTLAND—Merchants on 4th street from Yamhill to Burnside streets petitioned City Council to install lighting system at their own expense. Plans contemplate large bracket lights to line both sides of the street without arches.——The port of Portland (M. Talbot, general manager, Court House), proposes to make a survey of harbor and then dredge it out to a depth of 30 to 35 ft. This will probably be done during the coming winter and spring.——Bids for construction of $160,000 Shattuck school and school property, Broadway, College, Hall, and Park streets, will be called soon. F. A. Naramore is in charge.——Property owners on 4th street, from Yamhill to Burnside streets, granted permission to City Commission to install system of ornamental street lighting.——Oregon State Highway Commission has taken over completion of Columbia highway from Sandy river to Wood River county line, on account of the depleted county road fund and will supervise expenditure of $50,000 contributed by citizens of Portland for that purpose.——Capitalists of Portland and San Francisco have completed consolidation of Crown Columbia Paper Co. and Willamette Pulp & Paper Co. under the name of Crown-Willamette Paper Co.; authorized capitalization, $13,000,000. Company will operate mills at Camas, Washington, and Floriston, California, and in addition will maintain large concerns in Los Angeles and San Francisco, whose capacity will be equal to that of other Pacific Coast mills. Principal plant of Willamette Pulp & Paper Co. is at Oregon City, Oregon.——Contract for construction of one level open dock to be built by Southern Pacific company on west side of Willamette river between Davis and Everett streets, has been awarded to International Construction Co. Estimated cost $12,000. H. A. Hampton, engineer, S. P., Wells Fargo building, supervised construction of plans.——Following bids have been received by City Council: For improvement of East 19th street by grading and sidewalks, Bodman & Burge, $3510.10; Charles Solomon, $3497.85; Cochran, Nutting & Co., $3509.65; Manning & Co., $3499.78; Arthur D. Kern, $3531.48. For the improvements of Market street from Vista avenue to 19th street, Oregon Hassam Paving Co., class B hassam, $4191.55; F. H. Howard, macadam, $1789.25; Giebisch & Joplin, macadam, $1893.03.——Multnomah county will issue $125,000 worth of bonds to bear 5% interest, and if necessary a further issue of $250,000, in order to build necessary interstate bridges. Interstate Bridge County Committee consists of County Clerk Coffee and County Commissioners Holman, Lightner, and Hart.——Port Commission filed plans for a wooden warehouse on Municipal Dock No. 1, on Front street, to be 230 by 206 ft. and to cost $30,600.——Terry & Harris, realty operators, Yeon building, are negotiating with promoters for site on which they plan the construction of a plant to manufacture cast iron water and gas pipe and fittings. Estimated cost $100,000. Plans for building have been prepared.——Plans are being made by Lewis Hobart of San Francisco for the $1,000,000 Portland post-office. Formal calls for bids have not yet been received from supervising architects at Washington, but it is expected will be taken about December 1.——Contract for the Willow-East 82nd Street sewer system will probably be let the latter part of this month. Estimated cost between $183,727 and $196,997.——Government Standard Powder Co., of Oregon, has organized for erection of a powder plant, about one-half mile from Canby. Building will be erected before January 1, at cost of $7000. R. W. Woods, of Portland, is president.——Bids are being received for construction of warehouse, junction, with municipal dock No. 1, in accordance with plans drawn by G. Hegardt, engineer for public dock commission. Building will be one story high, 230 by 210 ft. dimensions, of heavy mill and timber construction.——Bids will be called in a few days for driving concrete piling for five-story Blake McFall building, MacNaughton & Raymond, architects, Title & Trust building. Estimated cost $90,000.——Bids will be received until November 5 at office of U. S. Engineers, C. H. McKinstry, Lieutenant Colonel Engineers, Custom House, for construction of wooden hull of combination dredge and snagboat. Morris Machine Works double-cylinder 50-hp. engine and 10-in. pumps will be installed.——Specifications for $12,000 worth of fire hose will be opened to competition by all makers, according to latest decision of City Commission.——Bids opened by Commission of Public Docks for warehouse at rear of Municipal Dock No. 1. Anton Teller, submits lowest bid $30,290, or $30,600 if a sewer is included. Brayton Engineering Co. bids $31,650, and $32,350 for the alternative. Sound Construction & Engineering Co. bids $32,215, or $32,795.——Latter Day Saints plan construction of church on corner of East 25th and East Madison streets. Architect, Pope & Burton. Estimated cost of a 40 by 60-ft. building $20,000.——Oregon-Washington Railroad & Navigation Co. filed plans with the Board of Public Works by which it can effect a saving of $22,800 in cost of abolishing grade crossings. Plan contemplates constructing overhead viaducts instead of lowering streets below tracks.——City of Portland will hereafter manufacture its own water meters. Machinery will be installed at municipal shops on East Washington street.——Parker & Banfield offered to construct city stables at 16th and Jefferson streets for $38,973. Twelve other firms figured on the work, some estimating the cost above $50,000, the estimate made by the architect, C. C. Rich.

SALEM—State Engineer J. H. Lewis has approved application of Goose Lake Valley Irrigation Co. for irrigation of 46,600 acres of land and construction of large reservoir in Goose Lake

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valley in southern part of Lake county.——State Highways Engineers are working at foot of Marion street to locate bridge foundation.——Great Northern Pacific Steamship Co. filed articles of incorporation with capitalization of $5,000,000. Company is a subsidiary of Hill lines and will engage in operating steamships and water craft on Columbia river and Pacific ocean. It now has two large passenger vessels nearing completion which will ply between Astoria and San Francisco.

ST. HELENS—County Commissioners award contract to Mills-Enstrom Co., of Vernonia, for $21,815.58, for construction of Pigttsburg-St. Helens road, to be built under Columbia County bond issue.

WASHINGTON

CATHLAMET—A warrant for $4200 has been issued for purpose of installing a municipal electric lighting plant. City owns its water system.

ELLENSBURG—Ellensburg Gas & Water Co. has in contemplation extension to supply pipe-line to village of Kittitas. Distribution system of about 3 miles would be included.——Cascade Irrigation District has arranged for the sale of over $100,000 worth of bonds, sufficient to replace wooden flume with steel. Contracts are reported to have been let for over 18,000 ft. of new steel flume, and it is announced that work will be done between now and first of next April. Total approximately $138,000. It is reported that the Hess Flume Co., of Denver, has contract to furnish approximately $50,000 of steel flume. Coast Culvert & Flume Co., of Portland, will furnish 9000 ft. of flume and also take bonds in payment. R. W. Rhea, district engineer.

EVERETT—City Commission is reported to have selected W. R. Thompson, of Seattle, as engineer on proposed municipal water system, the cost of which is estimated at $100,000.——The Snohomish County Goods Roads Association votes to have proposition of bonding county for $1,500,000 for road purposes submitted to voters in the fall.

SEATTLE—City Council disapproved bill appropriating $8000 for construction of North pier to the Montlake avenue bridge, and decided against submitting a Latona Bridge proposition to voters at general election. Bill was passed transferring $51,000 from general fund to light fund for payment of cluster lights. ——Resolutions were introduced for following improvements: West side of Ranier avenue, Kenny to Thistle street, planking; Shoreland drive, Lake Park drive to Mount Claire drive, paving; west side of First avenue, north and south margin of Seneca street, concrete retaining wall; 32nd avenue northeast and 33rd avenue northeast, from East 60th to East 65th, and East 60th from the west margin of 32nd avenue northeast to the east margin of 33rd avenue northeast on the east, grading; Eli avenue et al., from West 70th street to West 75th street, sewers; North and East 40th street, from Woodland avenue to 6th avenue northeast, paving, sewers, water mains; 44th avenue south et al., from Alaska street to Angeline street, grading; 44th avenue south and 45th avenue south, from Hudson street to Ferdinand street, concrete sidewalks; Graham street from Beacon avenue to 42nd avenue, water mains; Dearborn street et al., paving; Pike street, from 1st to 7th avenue, asphalting.——Contract for foundation for Sears, Roebuck & Co., 9-story reinforced concrete building on Lander street, from Utah to Colorado, has been awarded to Pearson Construction Co, New York block, Seattle.——Estimates for municipal improvements for year 1915 have been completed by A. H. Dimock, City Engineer, and provide for the following expenditures: Paving, $2,375,303; concrete walks, $283,518; grading, $1,098,166; re-grading, $580,000; sewers, $506,074; water mains, $291,832; planking, $30,960; sanitary fills, $370,000; slides, $24,750; asphalt topping, $8750; bridges, $18,300; concrete sea-wall, $200,000; trunk water mains and extensions to city light and water system, $2,585,000; total, $8,386,803. The different projects involved in above expenditure of $2,595,000 for construction of trunk water mains and light and water system extensions include: Penstocks, extension of power plant, $525,000; surge tank (an extension to present power plant), $20,000; new power-house at Cedar Falls, $150,000; transmission line, $200,000; new power-house, machinery at Cedar Falls, $600,000; Pumping machinery, Green Lake reservoir, $200,000; covering Lincoln Park reservoir, $200,000; pipe changes at Landsburg, $85,000; municipal store yards, $6000; Beacon avenue supply main, $86,000; East 55th Street trunk main to Laurelhurst, $75,000; Dexter Avenue and Nickerson Street water mains, $45,000; Denny Way and East Denny Way water mains, $70,000; 42nd Avenue South trunk main to Rainier valley, $335,000; Alki Avenue trunk main, $78,000.——Eagle Harbor Transportation Co., Seattle, plans to call for bids for construction of 130-ft. passenger steamboat with speed of 15 knots. L. H. Coolidge, naval architect, has prepared plans. Estimated cost $38,000. Triple expansion oil-burning engines of 800 hp. specified.——County Commissioners have awarded contract for grading and graveling 4½ miles of road between 14th avenue south and Des Moines to Henry Bros., at $28,938.53. There were seven other bids. Contract for graveling an extension of county road from First avenue south was let to Charles C. Crane at $3800.——It is probable that a bridge pier will be constructed on the north side of Lake Washington canal at Montlake boulevard at cost of approximately $8000.——Port Commission votes to submit to voters on November 3, proposition of adding banks of Duwamish and Black rivers as units to commission's general scheme for development of Seattle's water front.——Board of County Commissioners has passed resolution to submit to voters in November a $350,000 additional county bond issue, money to be spent in erecting two additional stories for court-house and jail; extra floor space to be used by the city of Seattle. Addition to be constructed of terra cotta.——Seattle Machine Works bid $57,500 for construction of an 18-in. hydraulic electrically driven dredge to be used in deepening the channels of Stuck and Puyallup rivers, and digging three cut-offs to prevent floods of Duwamish valley. Other bidders: Yuba Construction Co., San Francisco, $67,700; Tweeden & Marsh, of Tacoma, $64,000; Washington Iron Works, Seattle, $65,000; Puget Sound Iron & Steel Works, of Tacoma, $67,000; Bucyrus Dredging Machinery Co., of Bucyrus, Ohio, $67,000; United Iron Works, Oakland, California, $64,000.——County Commissioners appropriated $20,400 for construction of 20th Avenue northeast bridge, crossing Ravenna park, money to be drawn from 1915 taxes, and payable after next February.——Port Commissioners asked Treasury Department to arrange to absorb at least $1,000,000 of port of Seattle 5% bonds, as they are prepared to sign a contract for a large cold-storage warehouse, but are unable to procure money by the sale of the bonds except at ruinous discounts.——Superintendent of Water, L. B. Youngs, will begin work this month on the construction of two steel water mains within city limits, which will cost between $75,000 and $100,000; 36-in. pipe connecting Volunteer Park reservoir with Lincoln Park reservoir, and pipe-line No. 1 are to be replaced.——County Commissioners will probably appropriate from $58,000 to $68,000 for the purchase of a site and construction of a brick fire-proof detention home for children. Architect A. Warren Gould has prepared tentative plans for building that will cost approximately $48,000.——Plans for main operating house, electric light standards, light houses, and smaller operating houses have been completed by Bebb & Gould, Denney building, consulting architects for government buildings on Lake Washington Canal lock site.——T. A. Rapp, Structural Engineer, City Engineer's Department, room 307 City Hall, is preparing plans for two bridges of trunnion bascule type to be constructed over Lake Washington canal; one at 15th avenue northwest to cost $460,000; the other at Fremont avenue, $420,000.——Contract awarded to Reinseth Bros. at $11,130 for construction of W. D. Perkins road.——Long Building Co., 209 New York block, will build a concrete garage to cost $30,000 at 1512 8th avenue for W. G. Barner, 3922 Eastern avenue.——F. H. Linthicum, representing National Steel Foundries of Milwaukee, contemplates erection of large foundry in this place.——Difflefsen & Gerring, 607 Leary building, awarded contract for 10-story reinforced concrete hotel building for Rainier Heat & Power Co., to be built at Jackson and Maynard avenues. Building will be fireproof structure, 105 by 120 ft., containing 467 rooms. Cost approximately $250,000.——President O. A. Fechter of Board of University Regents, states that the Legislature will be asked to appropriate $400,000 for the construction of two new buildings for the State University.——The City Council has approved the plan recommended by City Engineer providing for an expenditure of $10,000 for the preparation of plans and specifications for the bridges to span Lake Washington canal.——County Commissioners have decided not to purchase Houser dock site, for which they had appropriated $25,000.

SPOKANE—Fire destroyed the five-story warehouse of Holt Mfg. Co. Estimated loss $100,000, one-half of which was stock of tractors. Warehouse will be rebuilt at once, and orders supplied from factory at Stockton, California.——Contract for rebuilding Spokane Paper & Stationery Co. warehouse on Havermale avenue destroyed by fire, was awarded to Charles Jasper at price between $16,000 and $18,000. Work will start immediately.——Northern Pacific officials informed Commissioner McBroom that they propose to erect concrete bridges over street crossing in conjunction with grade separation contract recently awarded to W. J. Hoy & Co., of St. Paul, at Helena, Napa, Erie, and Madelia streets, in accordance with a recent agreement between the City Council and the railroad. These four structures are estimated to cost $175,000 in addition to grade separation cost. H. E. Stevens, bridge engineer.——Chief Engineer J. R. Holman, of Oregon, Washington Railroad & Navigation Co., states that work will begin in a few days on new round-house and shop near Nettleton street. Probable cost of new construction $170,000.

TACOMA—Residents in tide flats section bounded by Hylebos creek, Lincoln and Marshall avenues, have voted for construc-

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tion of dikes to protect approximately 2350 acres of land from water encroachment. H. C. Christy, William Mueller, and Henry Benthien, commissioners. Estimated cost $150,000. Commissioners will appoint engineer and start preliminary work at once. Tweeden & Marsh have been awarded contract by Commission of King and Pierce counties to construct 20-in. electric dredge upon bid of $72,000. Bid of Puget Sound Iron & Steel Works of Tacoma was lower by $3000, but upon recommendation of W. J. Roberts, engineer in charge of White-Stuck River flood improvement work, other bid was accepted. Cross, Rollins & Co., who have contract for dredging, agree to purchase dredge when work is completed, for 75% of its initial cost.——Public Works Commissioner Woods awards contract for paving strip of 3000 ft. of road connecting city and county pavements near Cushman Indian School to McHugh Contracting Co., on bid of $14,655. No other bids.——L. A. Nicholson, Fidelity building, is preparing plans for construction of channel running from tidewater to Julia's gulch for proposed Hylebos Creek waterway. Estimated cost $350,000. Channel is to be 2½ miles long and 400 ft. wide.

Personal

G. Vingen has been appointed deputy electrician for the city of Everett, Washington.

O. W. Lord has been appointed superintendent of public works for the city of Eureka, California.

Robert E. Kremers has been appointed chief of the bureau of highways and bridges for the city of Portland, Oregon.

O. L. Coward, of the Juneau, Alaska, office of the General Electric Co., has been in Seattle for a few days on business.

Paul P. Whitham, consulting engineer of Seattle, Washington, has gone to Juneau, Alaska, on professional business.

C. W. Cochran, of Portland, Oregon, has been appointed assistant field engineer for the Interstate Commerce Commission.

David T. Day has resigned his position as statistician for the U. S. Geological Survey in order to engage in private practice.

S. J. Van Ornum, of San Francisco, has been appointed consulting engineer for the city of Oroville with reference to street improvements.

Edward R. Feicht, chief engineer for the Sacramento Valley Sugar Co., of Hamilton, California, has been in San Francisco for a two weeks' vacation.

J. R. West, formerly designing engineer for the Port of Seattle Commission, has been appointed chief engineer, succeeding Paul P. Whitman, who has resigned.

E. A. Jerome, of Seattle, Washington, has been awarded a contract to replace the plant of the Eastern Oregon Light & Power Co. which recently was destroyed by fire.

Dorsey Hager, consulting geological engineer of Los Angeles, California, will leave within a few days on a trip of inspection and investigation of the Oklahoma oilfields.

J. H. Dockweiler, consulting engineer of San Francisco, has been appointed municipal expert for the city of Oakland, California, with special reference to water-supply matters.

F. R. Schank, in charge of mechanical and electrical engineering work for the U. S. Indian Irrigation Service, has been appointed assistant chief engineer with headquarters removed from Los Angeles to Washington, D. C.

F. McN. Hamilton, California state mineralogist, R. P. McLaughlin, assistant in charge of the petroleum department, and W. W. Thayer, secretary, have recently completed an extended trip through California oilfields in connection with investigations of the water encroachment problem.

Austin B. Fletcher, California state highway engineer, recently delivered a lecture before the Harvard club of Santa Barbara with relation to the status of the work on the state highway. Mr. Fletcher will leave in a few days for Atlanta, Georgia, to preside over the forthcoming sessions of the American Road Congress, of which he is president.

Frank W. Skinner, M. Am. Soc. C. E., for many years senior associate editor for the *Engineering Record*, has opened offices as consulting engineer at 45 Broadway, New York, and is associated with C. E. Fowler, C.E., of Seattle, Washington. Mr. Skinner will continue in the field of bridge and structural steelwork, foundation and general civil engineering field construction methods, operations, and plant, with which he has long been intimately and extensively identified, and will also specialize in the preparation of engineering cases for litigation, expert witness, research, and testimony.

Commercial Paragraphs

California Trojan Powder Co. has just moved its offices to 733 Phelan building.

Superior Portland Cement Co. has removed its offices to 804-5-6 Hoge building, Seattle, Washington.

Western Equipment Co., 72 Fremont St., San Francisco, has issued a catalogue of loggers, mine, mill, and contractors' equipment. Illustrated.

Fairbanks Steam Shovel Co., Marion, Ohio, has issued a catalogue on dipper dredges showing full details, illustrations, and other data dealing with results in actual operation.

L. Y. Stayton, of Tacoma, Washington, has just completed large orders of 'Lone Star' cement pipe for the State Highway Commission at Sedro-Woolley, Hoods Canal, and Enumclaw, and also to Pierce county road work.

A 'Rapid Heated' mixer has been purchased by the city of Berkeley for repairing asphalt pavements, the order having been placed with the Edward R. Bacon Co. after competitive tests with several other machines under the direct supervision of the city engineer.

Pacific Tank & Pipe Co., through its Portland, Oregon, offices, has secured an order from the U. S. Reclamation Service, North Platte project, for 2406 feet of 24-in. diameter wood stave pipe, and for the Uncompahgre project, in Colorado, 8360 feet of 32-in. pipe.

Natomas Consolidated of California has purchased from Charles C. Moore & Co., Engineers, San Francisco, one 50-in. Platt Iron Works centrifugal pump. This makes a total of thirteen 50-in. pumps of this make sold within fifteen months in the Sacramento Valley district.

Catalogues Received

Western Electric Co., New York. Western Electric Poles, illustrated catalogue.

Austin Mfg. Co., Chicago. Illustrated catalogue, 'Modern Earth Handling Machinery.'

The Lima Locomotive & Machine Co., Lima, Ohio. General catalogue illustrating and describing locomotives of all types.

Contractors' Equipment Co., Portland, Oregon, and Seattle, Washington. General illustrated catalogue.

Buffalo Steam Roller Co., Buffalo, N. Y. Illustrated catalogue on Buffalo Pitts Tandem Rollers. Graves-Spear Road Machinery Co., agents, First and Jackson streets, Oakland, California.

Pawling & Harnischfeger Co., Milwaukee, Wisconsin. Bulletin No. 301A. Illustrating and describing the application of the electric hoist. Bulletin No. 8, illustrating and describing tamping machines. Edward R. Bacon Co., San Francisco, agents.

Busch-Sulzer Bros.-Diesel Engine Co., St. Louis, Mo., and Rialto Bdg., San Francisco, Cal. Bulletin No. 109, illustrated, showing typical performance curves and economy tests in a number of installations. Pamphlet, illustrated, showing in detail the acceptance tests and operating costs of the Diesel-engine plants operated by the Texas Power & Light Co. at Cleburne and Sherman, Texas.

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